Report On

THE 1949 WESTERN OREGON SPRUCE BUDWORM CONTROL PROJECT

By

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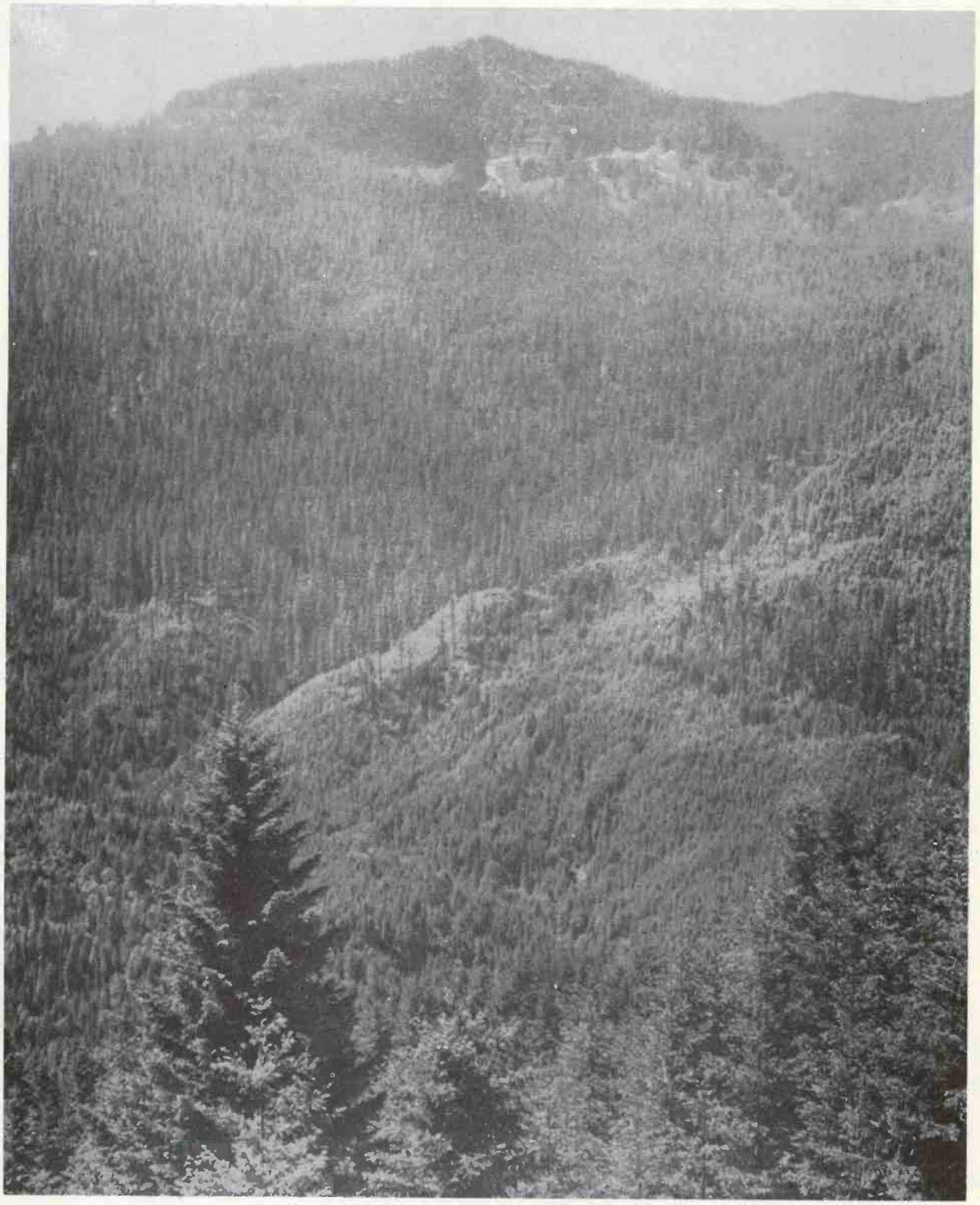

Typical Douglas-fir forest sprayed on the 1949 western Oregon spruce budworm spray project where 160,234 acres of high-value fir forest were sprayed at a total cost of $171,211--a per acre cost of $1.07. (Photo courtesy of Pacific Pictures, Salem, Oregon.)

ABSTRACT

During the period May 21 to June 19, 1949, some 161,000 acres of high-value Douglas-fir timber near Eugene, Oregon, were treated for control of the spruce budworm (Choristoneura fumiferana Clem.) by aerial spraying. Better than 95 percent of the budworm larvae were killed by the DDT insecticide at a cost of approximately $1.07 per acre.

The project was a cooperative undertaking, with 255 private timber owners, the Oregon State Board of Forestry and the U. S. government contributing to the cost of control. Federal and State funds were secured through direct appropriations while the private apportionment was obtained by assessment of timber holdings as authorized under the Oregon Insect Pest Act.

This project and a similar one of some 106,000 acres conducted simultaneously near Mt. Hood were necessary as the result of widely epidemic conditions of the budworm that began in eastern Oregon in 1944. By 1947 the infestation had reached 710,000 acres in extent in eastern Oregon and Washington and showed no signs of abating. Recognizing the seriousness of the situation, private, State, and Federal foresters and entomologists set out to devise a means of combating the insect. A highly successful experiment was carried out near Heppner, Oregon, in the spring of 1948. These tests showed that proper application of one gallon of a formulation of DDT, solvent, and fuel oil per acre resulted in a very high kill of the budworm larvae.

By the end of 1948 the outbreak covered 1,446,000 acres and had spread to the high-value Douglas-fir stands of western Oregon. Knowing that effective control methods were available, a committee representing private, state and federal interests formulated control plans for 1949. Because of the tremendous size of the infested area and the limited supply of materials and services, it was necessary to set up control plans on a priority basis. The committee recommended that the Mt. Hood and western Oregon areas be treated in 1949. It also recommended that: (A) the U. S. Forest Service administer control of the Mt. Hood project, (B) the Oregon State Board of Forestry administer the western Oregon project and (C) the Bureau of Entomology and Plant Quarantine provide technical supervision for both projects. These recommendations were carried out.

As authorized by the Oregon Insect Pest Act, zones of infestation were declared by the Oregon State Forester on November 19, 1948, thereby assuring full cooperation by the state and the timber owners. During the fall and winter contacts were made with the many landowners involved; bids for supplying the insecticide were let; and the numerous other pre-control activities were inaugurated.

The following report describes the organization, conduct and results of the 1949 Western Oregon Spruce Budworm Control Project. Data on the biology of the budworm also are given.

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INTRODUCTION

The destructiveness of the spruce budworm is well known as the result of tremendous losses it has caused in the northeastern states and Canada, and to a lesser extent in the Rocky Mountain states. Accordingly, the present outbreak in Oregon and Washington is regarded with great concern. Experience with budworm infestations in the Rocky Mountains has shown that subsequent depredations by bark beetles in the heavily defoliated stands may be greater than the damage caused initially by the defoliator. These attacks, primarily by the Douglas-fir beetle (Dendroctonus pseudotsugae Hopk.) have often reached widespread proportions and extended beyond the defoliated timber into healthy stands.

Records of the spruce budworm in Oregon and Washington are not numerous. The first known record of the insect in the two states was in 1914 when one adult was reared from Douglas-fir collected near Ashland, Oregon. The insect was next noted in 1929 when small areas of infestation were found at Northport, Washington. In 1931, localized infestations were discovered south of Mitchell, Oregon. In 1941 and 1942 a small outbreak was noted in the Warner Mountains southeast of Lakeview, Oregon. The first outbreak of size occurred in 1943 in the Methow Valley in north central Washington and in the following few years it spread over much of the Chelan National Forest and adjoining areas. Heavy defoliation occurred in some areas but little or no mortality is known to have resulted. This infestation subsided from natural causes in 1948.

In 1944 a light infestation of budworm was discovered in Douglas-fir and true fir on the Heppner Ranger District of the Umatilla National Forest. Surveys conducted by the Bureau of Entomology and Plant Quarantine in 1947 recorded a spread of this infestation to 710,000 acres.(1)[1] By 1948, 1,446,000 acres(5) of fir, mainly in the Blue Mountains region of Oregon, were infested and some tree killing was in progress. A relatively small part of the infested acreage was in the Blue Mountains region of extreme southeastern Washington.

The first record of infestation west of the Cascades was in 1948 in the vicinity of Eugene, Oregon. Approximately 86,200 acres of infestation, of light to heavy intensity, were recorded by aerial surveys conducted by the State Board of Forestry and the Bureau of Entomology and Plant Quarantine. This same year 102,000 acres of infestation were discovered on the Mt. Hood National Forest immediately east of the Cascade summit.

By the end of the 1947 season all indications pointed to a continuing spread of the budworm epidemic through the valuable fir forests of the Northwest. Recognizing the seriousness of the situation, foresters and entomologists set out to devise methods to control the insect. Using the most promising insecticides and methods of aerial spraying tested

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1/ Numbers in parentheses indicate references listed on page 35 of this report.

in Canada and the New England states against the budworm, a highly successful experiment[1] was carried out in the spring of 1948 in the Blue Mountains near Heppner, Oregon.(3) Using a formulation with DDT as the toxicant, upwards of 95 percent of the budworm were killed on the experimental spray area of some 4,500 acres.

With the Heppner experimental project as a guide, a committee representing timber owners and land-managing agencies met in November of 1948 to consider plans for controlling the budworm in 1949. On November 12, 1948, a plan for control of the spruce budworm in Oregon was released.(8) The Action Committee[2] recommended that control of the budworm on the infested areas be in the following order of priority: (1) western Oregon area, (2) Mt. Hood area, and (3) Blue Mountain area. Control on the western Oregon and Mt. Hood areas was recommended for 1949. The committee proposed that the western Oregon area be administered by the Oregon State Forester, with technical assistance from the Bureau of Entomology and Plant Quarantine, and with financial help from federal agencies and private owners. The Mt. Hood area was to be administered by the U. S. Forest Service, with the Bureau again providing technical supervision. The Blue Mountain area was scheduled for treatment at a later date.

The following report is concerned with the planning, conduct and results of the western Oregon or so-called Eugene project administered by the State of Oregon. The details of the Mt. Hood project, administered by the U. S. Forest Service, have been reported elsewhere.(2), (6), (7)

1/ Cooperators on this experiment were the Oregon State Board of Forestry, U. S. Bureau of Entomology and Plant Quarantine, U. S. Forest Service, and Kinzua Pine Mills Company.

2/ The committee consisted of the representatives of the following agencies and organizations:

West Coast Lumbermen's Association
Western Pine Association
Western Forestry and Conservation Association
Willamette Valley Tree Farms
Weyerhaeuser Timber Company
Fischer Lumber Company
Oregon State Board of Forestry
Oregon Extension Service
U. S. Forest Service
U. S. Bureau of Entomology and Plant Quarantine
U. S. Bureau of Land Management
U. S. Indian Service

AREAS TREATED AND VALUES INVOLVED

As recommended by the Action Committee, all known infestations in western Oregon were to be treated. Results of the 1948 detection survey showed some 86,200 acres of epidemic infestation ranging from light to heavy in intensity. Allowing for extension of boundaries, the committee recommended that control plans be made on the basis of 100,000 acres. By the time the project was completed however, 160,234 acres had been sprayed. This large increase in acreage was due to: (A) the addition of a one-half mile buffer zone of 19,714 acres around the infested areas and, (B) the addition of an area of 40,520 acres of very light infestation adjacent to the Springfield unit, on which large timber companies desired treatment so as to prevent reinfestation of the already treated centers. The control units and acreages sprayed are given in Table I. More detailed information as to timber types, elevations and amount of insecticide applied is presented in the section of this report beginning on page 10.

The area sprayed in western Oregon in 1949 is in the center of one of the most important timber-producing areas in Oregon (see map in the Appendix). The affected timber stands, largely second-growth Douglas-fir of saw-timber size, are of great importance to the sustained yield programs of the forest industries of this region. On the total of approximately 161,000 acres treated, assuming a conservative average volume of 20,000 board feet per acre and an average stumpage value of $10.00 per thousand board feet, the stumpage value alone of the infested timber is at least $32,000,000. This does not take into account watershed, recreation and wildlife values that were threatened by the outbreak.

THE OUTBREAK

Discovery and Definition of the Infestation

Prior to 1948, the known outbreaks of the spruce budworm in Oregon and Washington apparently were confined to the Douglas-fir and white-fir forests east of the Cascade Mountains. In August of 1948 heavy defoliation of a stand of second-growth Douglas-fir was observed from the ground near Springfield, Oregon. Later the damage was identified as that of the spruce budworm and an aerial survey was immediately undertaken to determine the extent of the infested area.

Aerial Survey - In all, approximately 500,000 forested acres were flown in Linn and Lane counties. Although many of the budworm-damaged needles, which are the evidence of attack seen from the air, had already been removed from the trees by unusually severe summer storms, a total of some 86,200 acres infested in epidemic proportions were observed and mapped.(9) The survey included two phases--the reconnaissance, in which all timbered areas showing signs of defoliation were tentatively located; and a later phase which included flying the boundaries of the areas and locating them accurately in relation to topographical features on the best maps available. Local foresters were used as observers to facilitate this second phase which was completed in September.

Ground Checking - Following the aerial survey a ground check was conducted to determine the accuracy of the aerial observations and to locate any areas of infestation that had been missed. Using as a guide the best known boundaries of the infestation as determined from the aerial survey and located on the few aerial photographs available, the ground checking was begun on December 6, 1948. The initial work was done in the field by Lee Harter and Al Lindsten of the Oregon State Board of Forestry. The ground checking was completed on December 24, 1948 on some 80,000 acres comprising the Springfield-Brownsville unit, the Cottage Grove unit, and the Lowell unit. This left some 20,000 acres in the Oakridge unit to be checked the following spring.

On March 1, 1949, a snowshoe trip was made to the Little Bunch Grass area near Oakridge to check infestation boundaries on this unit. As a means of establishing these boundaries, bark samples containing hibernating larvae were taken to determine the presence or absence of budworm in this area of doubtful infestation and also to determine the degree of expected infestation if the insect was present.

On the ground checking and placement of the Springfield-Brownsville unit boundaries, considerable cooperation was obtained from the Fischer Lumber Company whose forester, Bill Wilt, spent considerable time in the field checking boundaries of the infestation as mapped by the aerial survey.

After the ground checking was completed an additional one-half mile buffer zone was added to all boundaries which did not end at the edge of susceptible type. It was believed that this buffer zone would encompass the bulk of the spread of the infestation from the previous year's boundaries.

It was found that there was remarkable accuracy in the infestation boundaries as determined from the aerial survey, showing that considerable time could be saved in ground checking by careful placement of the boundaries at the time of the aerial observations. To accomplish this, good maps are essential, with topographical maps generally regarded as being the best. Some ground checking is practically always needed due to the fact that light and very light infestations of spruce budworm are difficult to detect from the air.

Ownerships Involved and Cooperative Efforts Undertaken

The western Oregon spruce budworm control project was in its entirety a cooperative undertaking, with private landowners, federal agencies, extension services, fire patrol associations, and county and state agencies being involved. The County Assessors' offices were especially cooperative in providing landowners' names and addresses. Due to the great turnover of land and timber ownership in Lane County, some difficulty was encountered in obtaining the names of the current land or timber owners. One of the first of several meetings of landowner cooperators was on February 18, 1949, at the annual meeting of the Eastern Lane Fire Patrol Association where discussion was held on the spruce budworm situation and the action planned for the coming year. The Oregon State Board of Forestry kept the landowners informed of the progress of the project. Copies of the letters sent to the owners are included in Appendix II b - II d.

With the boundaries established by aerial survey and subsequent ground checking methods, the infested acreages were computed and the landowners notified of the cost of control on their holdings. It was found that the bulk of the acreage infested was located on the holdings of a few large timber owners. Early control agreements were mailed to the following companies: Fischer Lumber Company, Weyerhaeuser Timber Company, Booth-Kelly Lumber Company, Brownsville Timber Company, and Giustina Brothers Lumber Company.

A system involving personal contact, by a representative of the State Forester, with the large number of small landowners was also established. This personal contact was to: (A) verify the acreage and ownership as computed from aerial photographs and the records of the County Assessor's office; (B) explain the purpose of the spray work; (C) find out if the landowner was in close proximity to bee hives, mink, turkeys or other crops and animals susceptible to spray or aircraft disturbance; and (D) obtain written assurance from the owner of his willingness to cooperate in the cost of the project. This personal contact work was started on March 9, 1949.

Cooperative agreements between the Oregon State Board of Forestry and the Federal government for spraying the public lands were also drafted. Copies of these agreements are included in Appendix II f and II g.

In some cases it was necessary for the state representative to go into the field with the landowner and inspect his timber, but usually by having aerial photos of the owner's holdings in hand at the time of the contact, agreement was quickly reached as to the amount of timberland the landowner held within the boundaries of the infestation. Much valuable time was saved in this manner. If the acreage was correct and an agreement reached with the landowner, his signature, implying his willingness to cooperate, was obtained (Appendix II a). Subsequently a short cooperative agreement (Appendix II e) describing the exact acreages and costs involved was mailed to the landowner, which he signed and returned to the State Forester's office in Salem. A total of 255 ownerships were involved in the project. The nature of the ownership is shown in Table I which follows.

TABLE I

OWNERSHIP BY UNITS

Ownership	Browns-ville (acres)	Spring-field (acres)	Marcola (acres)	Lowell (acres)	Cottage Grove (acres)	Oakridge (acres)	Total (acres)
Private	18,357	43,272	26,789	5,648	9,963	140	104,169
State & County	19	191	345	160			715
Bureau of Land Management	40	16,142	13,306	2,414	2,132		34,034
Public Domain		100	80		55		235
Forest Service				2,404		18,677	21,081
	18,416	59,705	40,520	10,626	12,150	18,817	160,234

PRELIMINARY CONTROL PLANNING AND PREPARATION

The Heppner Spruce Budworm Research Project - A Basis for Control

As previously mentioned, the widespread epidemic situation at the end of the 1947 season, combined with the well-known destructiveness of the spruce budworm, indicated an urgent need for control measures to suppress the epidemic. To meet this need, a large-scale experiment, employing the most promising measures developed in the northeastern states and eastern Canada, was conducted from May to July, 1948, on the Heppner Ranger District of the Umatilla National Forest and adjacent private lands in northeastern Oregon. This experiment was a cooperative effort of the Oregon State Board of Forestry, the Bureau of Entomology and Plant Quarantine, the U. S. Forest Service, and the Kinzua Pine Mills Company. This experiment proved that the aerial application either by airplane or helicopter, of one pound of DDT in one gallon of petroleum solvent and carrier, would give upward of 95 percent control if applied at the rate of one gallon of formulation per acre and properly timed.(3), (4).

The techniques developed for spraying, sampling the insect population and evaluating control on the Heppner project were the guides used for conducting the Western Oregon Project.

Estimated Control Costs and Apportionment

On February 10, 1949, a meeting was held in Portland between representatives of the Bureau of Entomology and Plant Quarantine, the U. S. Forest Service and Oregon State Board of Forestry. At this meeting a tentative cost per acre figure was determined which would probably cover the cost of the control work. A figure of $1.60 per acre was decided to be the best estimate obtainable at the time. This estimate was used when informing the landowners of their share of the cost of the project.

As the western Oregon spruce budworm control spray project involved private, state and federal lands, it was necessary that a method for equitably apportioning the cost of control be developed. Through meetings of the agencies and landowners, the following plan was approved for apportioning the costs for the project.

1. The public agencies pay 100 percent of the cost of treatment on publicly-owned lands.

2. Private owners pay 25 percent of the cost of treatment of their lands.

3. That 50 percent of the cost of treatment of private lands be borne by the state and the remaining 25 percent by the federal government.

This plan was used throughout the western Oregon project with the exception of the Marcola unit of 40,520 acres which was not set up for spraying until after control had started. On this unit it was evident that there was not time for the state to contact all landowners involved. Consequently, the following plan was adopted and approved by all interests for the Marcola unit:

1. The large private owners pay 75 percent of the cost on their lands, the federal government paying the additional 25 percent.

2. The federal government pay 100 percent of the costs on all federal lands.

3. The state pay 75 percent of the costs on lands of small private owners, or a total not to exceed $10,000; the federal government paying the remaining 25 percent.

4. The state pay 100 percent on all state and county lands.

Bids and Contracts

Bids for equipment and services for the spraying were released on March 21, 1949. The resulting successful bidder was the Central Aircraft Company of Yakima, Washington, with a submitted cost figure of $0.615 per acre.

Bids for the supplying of insecticide for the aerial spraying were released on April 11, 1949. The successful bidder was the Pennsylvania Salt Manufacturing Company of Portland, Oregon, with a bid of $0.4244 per gallon.

Copies of the invitations to bid are given in Appendix III a and III b.

PROJECT ORGANIZATION AND OPERATION

Project Headquarters

One of the first requirements of the spray project was the establishment of a central project headquarters. The Eastern Lane Fire Patrol Association, under the supervision of Warden Jacob Smith, aided materially by providing excellent centrally-located facilities at their Springfield headquarters. Space was available for entomological work, for hanging maps, and for work progress meetings. Central radio and telephone communications were also made available at this headquarters.

Obtaining Air Fields

The problem of obtaining airplane and helicopter air fields was the responsibility of the contracted aircraft company. Personnel from the State Forester's office, however, aided in this work as they were more familiar with the areas and had done considerable advance work in locating suitable fields. Fields free of obstruction at least 1,000 feet long for the helicopters and 1,500 feet for the Stearman planes were needed. From previous operations, it was known that airstrips located near the spray areas were necessary.

Only two suitable permanent airports were available, one at Springfield, adjacent to the Springfield unit, and one at Saginaw, adjacent to the Cottage Grove unit. Adequate sites for temporary strips were found at Pierce Creek, Brownsville, Marcola, and High Prairie for the airplanes. Smaller fields for the operation of helicopters were located at Lowell and Oakridge.

In normal use the airfields at Pierce Creek, Brownsville and High Prairie were grain fields, and the Lowell and Oakridge fields were pastures. These were rented by the aircraft contractor. Any damage occurring to animals or property during the course of the spraying was to be paid for by the contractor.

As the number of aircraft operating from the Marcola field totaled seven planes during one phase of the operation, two runways were installed, one for landings and one for take-offs.

Defining and Scheduling Blocks for Treatment

Use of Aerial Photos - This project proved the almost indispensable value of aerial photographs for work of this kind. It was necessary to contact many sources before all the photos needed were obtained. The Springfield-Brownsville unit was a section of an area which had been flown in 1948 by the Coast and Geodetic Survey and these photographs were made available to the State at a nominal fee. The Fischer Lumber Company had an aerial photo mosaic of a large part of

the area, with section corners placed; consequently, the transferring of these control points to the State's pictures was an easy problem.

The Oakridge and Lowell areas had been photographed for the U. S. Forest Service. Copies of these photographs, along with available section corner data, were obtained from the Survey and Maps Section, U. S. Forest Service, in Portland. There were no photographs of the Cottage Grove area; consequently, considerable difficulty was encountered in the laying out of blocks and establishing of ownership boundaries.

After all available photos had been secured, aerial photo mosaics were made of the areas to be treated. With these mosaics in hand, the chief pilot flew over the respective areas, defining and locating in place on the mosaics the individual spray blocks by using ridge tops, well-defined drainages, roads, cutting lines and timber types as boundaries. Each spray block was numbered and the acreage determined with a planimeter. From the mosaic showing the unit and block boundaries, a two inch to the mile base map was made on which the daily progress of spraying was recorded.

The Control Units - Each control unit was divided into spray blocks, averaging about 1,000 acres each, which could be readily sprayed from a designated airfield. The names of the units, as well as acreages, elevations, number of gallons of spray distributed and timber types present were as follows:

Brownsville Unit:

Area: 23,597 acres.
Elevation: 306 feet to 1,562 feet.
Distribution: 22,498 gallons on 18,415.78 acres.

The forest on this area is mainly second-growth Douglas-fir and reproduction and a relatively small amount of old-growth timber. Many nontimbered openings in the area made spraying difficult and resulted in the use of more than one gallon of insecticide per acre because it was usually impossible or impractical to discontinue spray application over small openings in the forest.

Springfield Unit:

Area: 65,426 acres.
Elevation: 309 feet to 3,420 feet.
Distribution: 63,091 gallons on 59,705.47 acres.

This was the largestunit of the project and the timber here was regarded as having the highest value of any of the units. Considerable old-growth timber under O. & C. Administration was involved as well as a sustained yield unit owned by the Fischer Lumber Company. Patches of Douglas-fir and true fir second growth and reproduction in other ownerships were also included in this unit.

Cottage Grove Unit:

Area: 12,151 acres.
Elevation: 573 feet to 2,934 feet.
Distribution: 11,383 gallons on 12,150.27 acres.

The bulk of the timber on this unit consists of high-value second-growth and old-growth Douglas-fir with a minimum of the smaller size classes.

Lowell Unit:

Area: 11,257 acres.
Elevation: 728 feet to 3,025 feet.
Distribution: 9,751 gallons on 10,625.66 acres.

The stands found here are made up of second-growth or old-growth timber of relatively high value. Logging was in progress at the time of treatment.

Oakridge Unit:

Area: 18,817 acres.
Elevation: 1,223 feet to 4,622 feet.
Distribution: 18,817 gallons on 18,817 acres.

A considerably larger acreage was treated here than originally planned which was due to the addition of a plantation area that harbored a light infestation. The old-growth and relatively young second-growth timber found on this unit are publicly owned and represent considerable value.

Marcola Unit:

Area: 40,520 acres.
Elevation: 325 feet to 3,200 feet.
Distribution: 40,520 gallons on 40,520 acres.

As previously stated, this area was scheduled for treatment after the project was well underway. Examination of this area, which is adjacent to the Springfield unit, disclosed a light population of budworm. Accordingly the private timber owners requested that control be applied in order to prevent reinfestation of the main centers. As equipment and insecticide were available, this was readily accomplished. The timber found here is mainly second-growth fir with a scattering of reproduction on previously-logged areas and also one small area of old growth.

Organization at Air Fields

At each airstrip an air field supervisor, a representative of the State Forester, was in charge and his duties were as follows:

1. See that each pilot was assigned a block for treatment.

2. Check with the pilots, between flights, on the progress of spraying on the blocks.

3. Check meter readings to see that each plane was properly loaded.

4. Check departure time of each plane. This served as a check for proper coverage and also as a safety measure.

5. Enter all information of plane loading in a record book kept for each plane.

6. Check weather reports every half hour with the weather observer stationed on the block being sprayed, and when wind velocities reached five miles per hour, make quarter-hour contacts. Shut down all spraying activities when critical wind or thermal-activity points were reached.

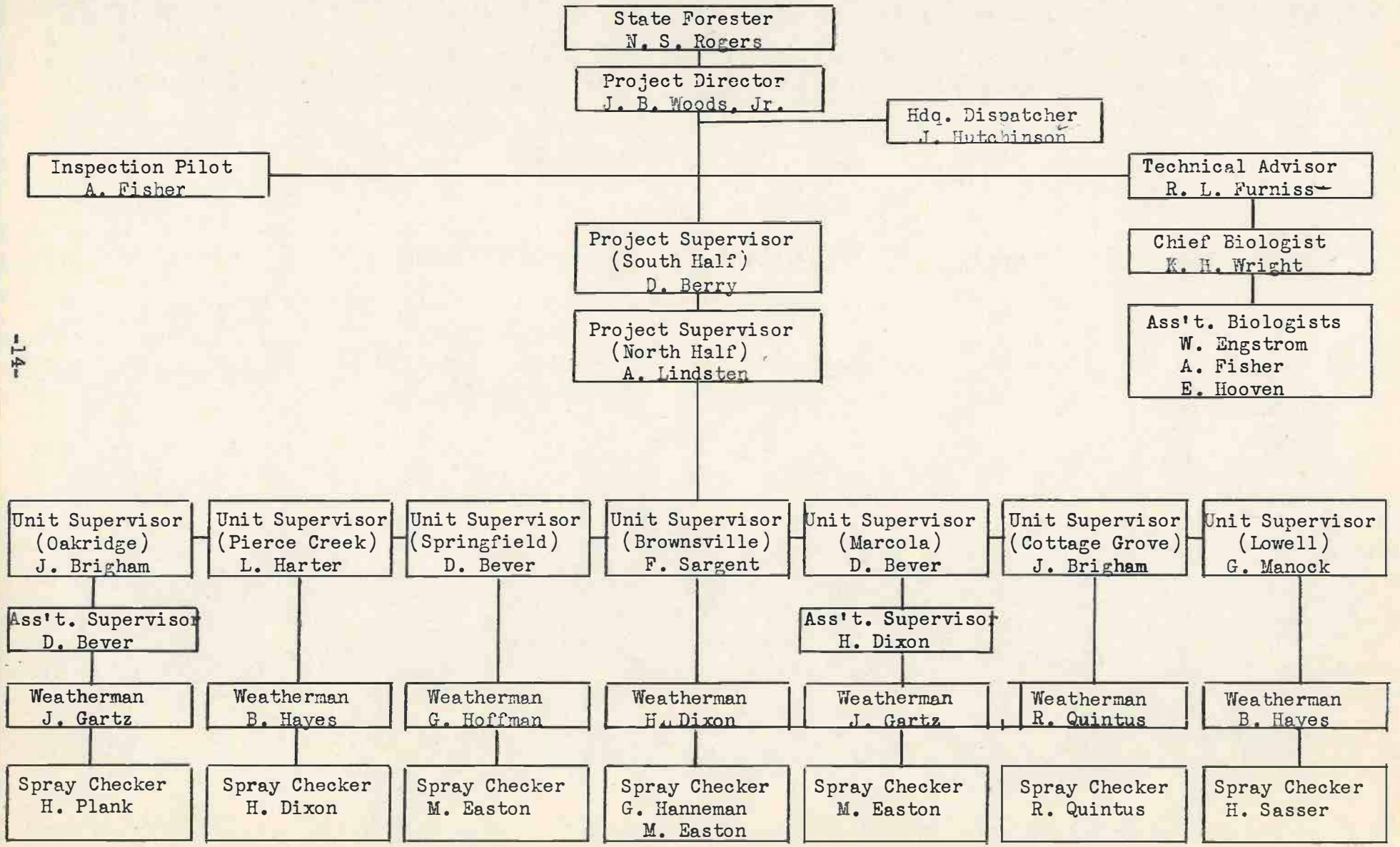
7. Check with each pilot at the end of the day's operations on area coverage as indicated by the pilots on the aerial photos. Enter this information on base map each night at project headquarters and make the following day's operational plans.

The air field supervisor was periodically assisted by additional personnel when a large number of operating planes made the detailed checking excessive for one man.

Also located at each field were two plane loaders, supplied by the spray contractor. Provision of all plane-loading equipment and meters, as well as airstrip storage and scheduling delivery of insecticide were the responsibility of the contractor. Two aircraft mechanics, equipped with a portable shop, were employed by the contractor to service the planes at the six air fields. Each field maintained a supply of gasoline and lubricating oils, also supplied by the aircraft company. Insecticide supply and transportation were provided by the insecticide company, as required in the bid agreement.

The following chart illustrates the over-all organization of the project.

PROJECT ORGANIZATION CHART



CONTROL OPERATIONS

Assignment of Spray Blocks

Shortly before a particular spray block was ready for treatment, the Chief Pilot took the spray pilots over their assigned blocks and showed them the respective boundaries and made recommendations as needed. From this information, the pilots could determine the most efficient flight pattern to thoroughly and quickly cover their area. The flight patterns most commonly used were contour or gridiron, with some cross-patterning used to cover deep canyons.

To further aid the spray pilots, copies of aerial photographs on which the spray blocks were outlined were made available. These photos were carried by the pilots while actually spraying and were of great assistance to them in keeping accurately located at all times in respect to the block boundaries. The photos were also used by the pilots when informing the unit supervisor as to their progress on the various spray blocks. At the end of each day's spraying, the pilots indicated on the photos how much area they had covered and from this information the following day's work schedule could be planned.

Aircraft Used

The aircraft company contracted to apply the insecticide, Central Aircraft of Yakima, Washington, had other spray and dusting jobs to complete; accordingly, the step-up of the date for beginning spraying resulted in their having to rapidly mobilize planes, pumps, and other equipment needed for the project. As quickly as equipment was available, it was rushed to Eugene. By May 21 four airplanes and sufficient ground equipment were on hand and spraying began on that date. At the peak of operations, thirteen Stearman airplanes, equipped with 300 to 450 h.p. engines, and three Bell helicopters were in action. Photographs of these aircraft are shown on page 19.

The table in Appendix VI summarizes the plane performance records. The airplanes consistently treated a much larger area than the helicopters in the same length of time, this increase of acreage treated being achieved despite the longer ferry distance required of the planes.

Delivery of Insecticide

The Pennsylvania Salt Manufacturing Company gave assurance that a supply of the insecticide would be in storage at Eugene in advance of the date designated by the project supervisor for initiating spraying. Samples of the formulated insecticide were taken from the tank cars at the company's plant in Portland and air-dispatched to Dr. W. E. Westlake

of the Bureau of Entomology and Plant Quarantine, Yakima, Washington, for testing the content of DDT in each tank car. The analyses disclosed the following DDT concentrations.

Car No.	Pounds of DDT Per Gallon
1	1.04
2	1.01
3	1.04
4	1.05
5	1.04

Spray Application

The spray application began at daybreak, usually between 4:00 and 5:00 a.m. and continued until wind velocities exceeded six miles per hour, or thermal activity caused the spray to dissipate and the flying to become hazardous. These conditions were usually encountered by late morning and by noon on most days operations were shut down. On the rough terrain of the Lowell and Oakridge units, where the helicopters operated, it was observed that by 8:00 or 9:00 a.m. wind and thermal activity prevented the spray from settling into the trees, resulting in cessation of work. Some evening spraying was feasible following cloudy days which prevented excessive heating of the ground and consequent adverse thermal action.

The acreage of each unit as compared with the prescribed volume of insecticide to be applied was checked by the pilots and the unit supervisors following completion of each block. In a very few instances blocks were covered with less than the prescribed amount and had to be partially retreated.

Weather, particularly rain, is perhaps the most important factor governing the success of an aerial spray project. On the 1949 project only one full day of spraying was lost due to rain. When precipitation did occur during the night, no spraying was permitted the following morning until the foliage was sufficiently dry to prevent run-off of the spray. The western Oregon project was fortunate in that generally good flying and spray application conditions existed almost throughout the entire spray period. Overcast conditions were encountered on several days but spray application continued satisfactorily.

Checking Spray Distribution

Checking spray deposit and coverage on each block was one of the important activities. The information gathered from field observations determined whether the spray was being adequately dispersed. The performance of the aircraft spray-dispersal apparatus in regulating droplet size and quantity of spray, as well as the pilot's uniformity of

distribution, was checked on the ground by means of small glass plates. These plates were plain window glass, four inches by four inches in size, placed randomly along lines run at right angles to the swaths of the applied spray.

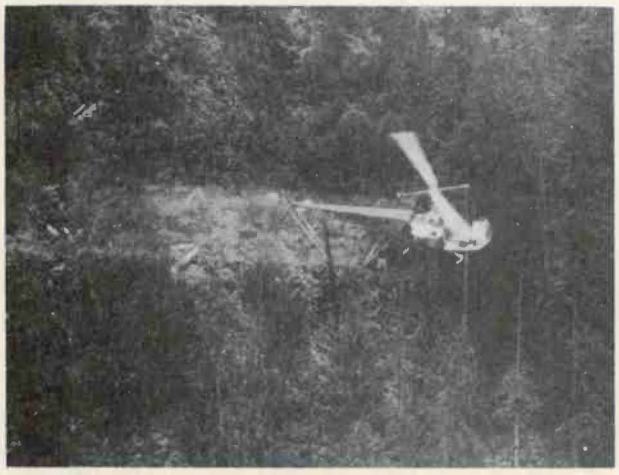
The checking of spray deposit was conducted by spray checkers working from the various fields. Single checkers working from each airfield were found to be adequate except at Brownsville and Marcola where three men were needed, due to the inaccessibility of the spray blocks and the numerous planes operating from these fields. The men operated separately and scheduled their work so that each block sprayed would be checked on the same day it was treated. The accessibility of spray areas by roads is immensely important in keeping up with this work as spraying progresses. Some difficulty was encountered on the project in gaining access to remote areas.

Additional checks of spray distribution were made by: (A) observing leaves of broadleaf shrubs for presence of oil burns and (B) checking the presence of oil deposit on water puddles. Some spray dispersal checking was also done from the air, by supervising personnel, and in future operations it is recommended that this method be used more extensively. Observance of spray pattern as well as completeness of coverage, safety precautions being exhibited, and compliance with spraying specifications by the pilots can readily be accomplished from an observation plane.

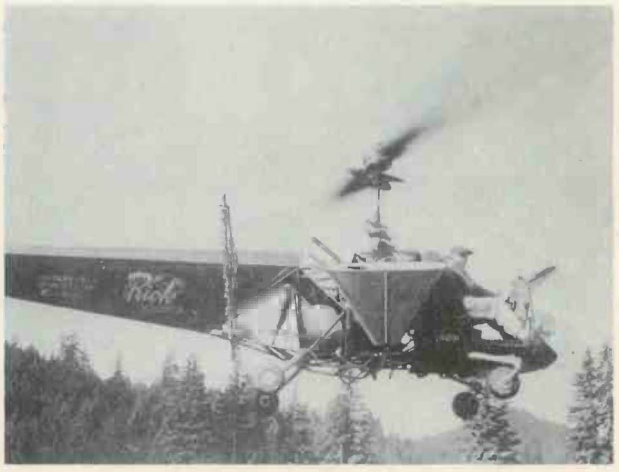
1. Stearman plane spraying high-volume stand of fir.

2. Typical spray pattern from Stearman-type plane.

3. Lineup of spray planes operating from Marcola airstrip.



4. Typical low-level spraying by helicopter.



5. Bell helicopter, showing placement of insecticide tanks and spray apparatus.

RESULTS

As previously stated, spraying began on May 21. As the larvae developed and became susceptible to spray under the great variety of elevations and exposures represented on the various units and blocks, spraying was continued and finally completed at Oakridge on June 19. A total of 160,234 timbered acres were sprayed.

Larval Mortality

Results of the mortality checking showed a high percentage of kill on all areas. Control figures on the 11 sampled units varied from 87.9 percent to 100 percent with an average of 97.7 percent for all aircraft on all areas (Table II). Indications were that somewhat more effective control was obtained by airplane than by helicopter. A good explanation for this difference is not known as excellent application and coverage were obtained from both types of aircraft. Observations by various personnel resulted in the opinion that wider lateral dispersion of spray was obtained from the airplanes than from the helicopters, thus giving more overlapping of swaths and lessening the probability of skips.

TABLE II

SUMMARY OF LARVAL MORTALITY ON THE WESTERN OREGON BUDWORM SPRAY PROJECT - 1949

Sample Area	Type of Aircraft	No. of Trees Sampled	Population Count Prior to Spraying	Population Count After Spraying	Per Cent Larval Mortality
Kampfer Ranch	Airplane	10	353	18	94.9
Pierce Creek	"	10	609	4	99.3
Cottage Grove	"	10	142	6	95.8
Seavies Ranch	"	10	646	18	97.2
Sodaville	"	10	362	4	98.9
Mt. Scott	"	10	210	0	100.0
Cougar Mountain	"	10	561	0	100.0
Gobel Creek	"	10	94	0	100.0
McCredie Springs	"	10	97	0	100.0
Lowell	Helicopter	10	91	11	87.9
Aubrey Mountain	"	10	559	25	95.5
Total		110	3,724	86	97.69

Average kill - airplane	98.49
Average kill - helicopter	91.70
Average kill - all aircraft	97.69

Project Costs

The total cost of treatment of the 160,234 acres sprayed was $171,221.11--a per acre cost of $1.07. These costs are low when compared to the estimates of $2.00 and $1.60 per acre that were made on different occasions by the control committee when planning the project.

The unexpectedly low treatment cost was mainly the result of low contract prices obtained on insecticide ($0.424 per gallon) and spray application ($0.615 per acre). The balance of the $1.07 total cost is attributed to miscellaneous services and equipment purchased during the project. It should be noted that salaries of State and Federal personnel assigned to the project are not included in the control costs. The following tabulations show the derivation of the cost figures and also the apportionment of costs among private, state and federal interests.

Computation of Cost Per Acre

Total Private Lands	104,169 acres
Total Federal Lands	55,350 acres
Total County and State Lands	715 acres
TOTAL	160,234 acres

Total Application Cost	$102,126.90
Total Insecticide Cost	69,094.21
TOTAL COST	$171,221.11

$$\text{Cost Per Acre} = \frac{171,221.11}{160,234.18} = \$1.0686$$

Apportionment of Costs

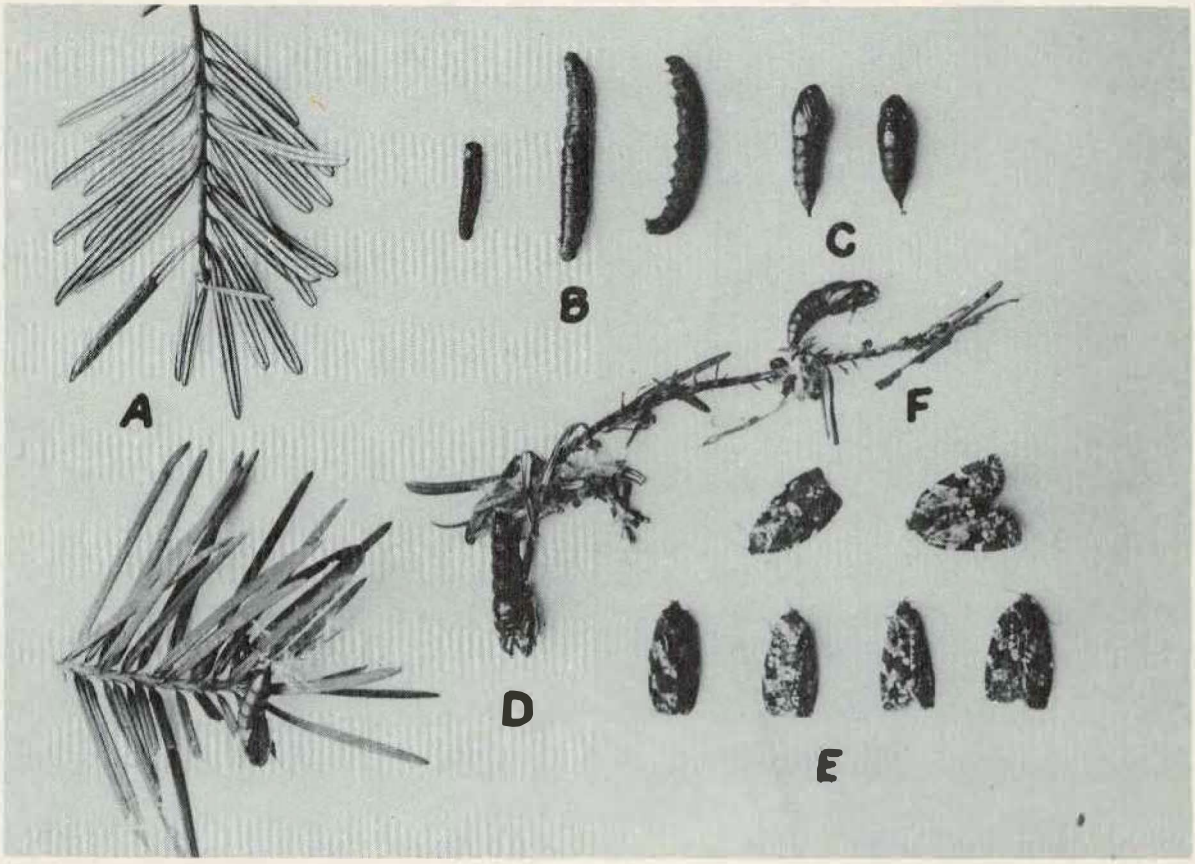
Private	$ 32,122.00
State	52,122.54
Federal	86,976.57
TOTAL	$171,221.11

General

At the completion of the western Oregon spruce budworm control project a regional aerial insect survey for 1949 was undertaken. While flying over the recently treated areas, a great difference was noted in the appearance of the sprayed area at this time as compared to a month earlier; it was most difficult to detect the areas where the foliage had been so severely attacked by the spruce budworm. From ground observations made about a month after treatment it was apparent that new growth was being established beyond the defoliated tips of the Douglas-fir and white fir.

Aerial operations of this type are recognizably hazardous to a certain degree; accordingly it is imperative that project personnel exercise the utmost in safety precautions in order to prevent accidents. On the western Oregon project two minor accidents and one of a more serious nature occurred. The latter occurred when a plane collided with a snag, resulting in considerable damage to the plane, but return to the airfield was accomplished. No fatalities or serious injuries were incurred on the project, however, several personnel, principally pilots, suffered from burns caused by contact with the insecticide formulation. It is believed that this situation can be remedied through use of tighter spray tanks on planes and more careful handling of the spray materials.

During the spraying operation all personnel accomplished their respective jobs in an excellent manner. The pilots performed their duties in a precise and outstandingly conscientious way. The success of any spray project hinges on the ability of the pilots to do a good job. It was generally felt by those connected with the project that, despite temporary setbacks, this cooperative project was an outstanding success.



Spruce budworm life stages showing: A. Egg mass on underside of needle, B. Larvae, C. Pupae, D. Empty pupal cases, E. Adults, F. Typical feeding.

BIOLOGICAL INVESTIGATIONS

Biology of the Budworm in Western Oregon

The life cycle of the spruce budworm is described in the following paragraphs. The various stages discussed are illustrated on page 25.

Adult Stage - The spruce budworm in the adult stage is a mottled buff to brown moth with a wingspread of about one inch. The moths emerge from the puparia about July 1 in western Oregon and some fifteen days later in eastern Oregon. There is quite a variation in these dates, dependent on climatic (mainly temperature) variation from year to year. Almost immediately after emergence, the female moth begins to lay clusters of eggs on the undersides of the Douglas fir, white fir or Engelmann spruce needles.

Egg Stage - The small, oval-shaped eggs are olive green in color and overlap longitudinally along the needle somewhat like fish scales. The number of eggs deposited in a cluster may vary from a few to nearly a hundred, with an average number of about forty to fifty. Fully gravid females are forced to deposit at least one egg mass before attaining flight, thus insuring a potential population on the parent host tree. Additional eggs, an average total of about 200 per female moth, are laid throughout the stand, with a somewhat greater number being deposited in the upper half of the crowns of the trees than in the lower half. With favorable wind currents, moths are capable of flying great distances, thus dispersing the eggs over a wide area. The moths may be seen for perhaps a two to three week period, after which they die.

Larval Stage - The eggs hatch anywhere from about six to fifteen days after being deposited, with the empty, semitransparent "shells" remaining on the needles for several months. The minute, newly-hatched larvae, which are about one-sixteenth inch in length, crawl about the branches for a short time until suitable hibernating locations are found. These are usually back toward the bole of the tree on the rough bark of the larger branches. Here hibernaculae, consisting of small webbed nests, are formed under bark scales, lichen or other protective material. Larvae in hibernaculae moult and overwinter in the second instar stage.

Hibernation is broken in the spring as soon as warm temperatures prevail. This is usually from about April 25 to May 20 in this region. The small larvae move toward the periphery of the tree and mine within the old needles while waiting for the new buds to expand. As soon as this occurs, entrance to the buds is gained by boring through the base of the bud or between the loosened bud scales. Once inside the bud, feeding and development are accelerated. Staminate and seed cones are also

attacked, with death of the cone usually resulting. The succulent new foliage is fed on until the supply is exhausted and then the old needles are attacked. The small, yellowish larvae continue to feed and moult until six (occasionally seven) larval stages - called instars - are passed. This period may last from three to five weeks, depending on temperature, humidity and other factors. When fully grown the larvae are about one inch in length, with a yellowish head and longitudinal black markings being characteristic features. This completes the destructive phase of the insect's life cycle. Larvae then transform into the pupal stage.

Pupal Stage - The pupal stage is a semidormant or resting phase where the adult features are formed. The pupae are found in the foliage, if remaining, or branch tips of the tree and are attached by webbing. Approximately six to fifteen days are spent in this stage of development, following which the moths emerge to complete the life cycle.

Population Studies

As budworm activity for the 1948 season had ended by the time the Bureau and the Oregon State Board of Forestry were aware of the existence of the western Oregon epidemic, little biological investigation was feasible prior to the spring of 1949. However, several reconnaissance trips into the defoliated areas indicated a high budworm population had been present in 1948. No evidence of significant natural control factors could be found.

Egg Collections - The only intensive biological investigations conducted in 1948 to determine the potential budworm population were made in early October when egg mass counts were made in the vicinity of Brownsville, Oregon. (See Table III.) The difficulty of sampling the large trees became apparent at this time. Thirteen trees of varying size and distributed over a wide area were felled and samples of the foliage taken. Empty egg cases were found in abundance on most trees. Assuming an average of 20 eggs per cluster, which had been determined by entomologists as the approximate figure for the insect as found in eastern Canada and New England, a larval population per tree of 0 to 17,280 was estimated. Later counts of the actual number of eggs per cluster indicated an average of 40 to 50 in this area. This would suggest a greater biotic potential by the insect in this region, although conclusive evidence of this point is lacking. In any event, it was apparent that the budworm population had gone into winter hibernation in great numbers.

Collections of Hibernating Larvae - To determine the status of the overwintering larvae, 11 collections of rough bark, limbs and twigs were made on February 1-2 in the various infestation centers. When brought into the laboratory, the larvae broke hibernation in seven days. Large numbers of larvae emerged from the material collected on the Sodaville, Pierce Creek, Coburg and Cottage Grove areas. The material collected from the heavily defoliated area at Oakridge yielded surprisingly few larvae. As egg masses had also been difficult to find in this area, the assumption was made that the moths had migrated to some other locality to deposit eggs. This

assumption proved to be true when spring larval activity began. However, the infestation center moved only a matter of about three miles, toward the town of Oakridge.

TABLE III

SPRUCE BUDWORM EGG MASS COUNTS
Brownsville, Oregon -- October, 1948
(Basis - 20 eggs per mass)

Tree No.	Species	D.B.H.	Crown Length (feet)	Extent of 1948 Damage	No. Branches	Sample Size	Egg Masses	Est. Population per Tree
1	D. Fir	3.5	22	Very Heavy	5	1/16	0	0
2	D. Fir	6.5	39	Very Heavy	5	1/16	17	5,440
3	D. Fir	4.2	18	Very Heavy	4	1/16	1	320
4	D. Fir	5.2	13	Mod. Heavy	5	1/8	3	480
5	D. Fir	6.1	32	Mod. Heavy	8	1/8	11	1,760
6	D. Fir	4.8	12	Moderate	4	1/16	7	2,240
7	D. Fir	8.2	49	Moderate	4	1/16	37	11,840
8	D. Fir	3.4	14	Moderate	5	1/16	2	640
9	W. Fir	3.0	11	Moderate	8	1/4	3	240
10	D. Fir	19.9	66	Light	6	1/16	54	17,280
11	W. Fir	9.1	55	Light	9	1/16	3	960
12	D. Fir	11.8	72	No. Defol.	9	1/16	0	0
13	D. Fir	6.5	34	No. Defol.	6	1/16	1	320
							Total for all trees	41,520

Larvae were still in hibernation on March 3 and 4 when 20 collections were taken for rearing. At this time an effort was made to obtain collections from all parts of the tree--needles, small twigs, small branches, large branches, smooth bark and rough bark--so as to accurately determine the favored hibernating locations of the insect. Collections were also made near and outside the infestation boundaries in an effort to determine the apparent concentration of the hibernating larvae and also to get some indication of the population dispersion by the egg-laying moths. Rearing results showed that rough limbs and crevassed bark of the large branches and main bole were, as previously found in eastern Oregon, the preferred hibernating places. The rearings from and beyond the periphery of the infestation yielded few larvae, indicating that a half-mile buffer strip drawn around the infestation proper would be adequate for control purposes.

Emergence from Hibernation - On April 27-29 a third trip was taken to the area to make further observations and collect rearing material.

Further rearings, however, proved to be no longer required as the larvae were found to be breaking hibernation on south and west slopes at low elevation.

Larvae were found mining in the needles and had in some instances entered the buds where development had been accelerated on warm exposures. Emergence at such an early date had not been anticipated because on the only previous observations in the Northwest, the Heppner project in 1948, larvae did not break hibernation until May 20. It was obvious that the abnormally early spring, with unusually warm days the latter half of April, had greatly speeded up both emergence and new foliage development. Snow was still to be found in practically all the Oakridge area at the time of this field trip.

Larval Development - With the discovery on April 27 of the early budworm activity, a speedup of spray plans was necessitated. A tentative date of June 1, rather than the expected June 10, was set as the probable start of spray operations.

In order to schedule the beginning of spray operations as closely as possible, close observation of larval progress on all areas was begun shortly after May 1. With bad roads existing throughout the 100-odd miles of scattered infestation, sampling of the insect population proved to be a difficult task. Prior to the establishment of a field laboratory at Springfield, collections of larvae were taken on the infestation units about every second day. The bulk of these larvae were collected by A. Fisher of the Oregon State Board of Forestry and sent to the Forest Insect Laboratory in Portland where they were separated by instar stages for the various locations represented. Following establishment of the field laboratory, daily collections from all areas were made whenever conditions permitted. Tables showing larval development are included in Appendix IV.

Continued warm days and nights throughout the first 20 days of May resulted in very rapid larval and foliage development, especially in the low elevation fringe timber. It became increasingly evident that the great variation in development from low to high elevation, and from south and west to north and east exposures, would require close scheduling of spray application on the various units.

Field collections on May 20 found small numbers of sixth-instar larvae present at Springfield, Pierce Creek, Brownsville and Cottage Grove. As a result spraying was scheduled to start as soon as equipment and insecticide could be made ready, with spray operations beginning May 21 at Springfield, May 22 at Pierce Creek and Cottage Grove and May 24 at Brownsville. Larval development at the time of initial application of insecticide on these units and at Oakridge where spraying was begun June 1 was as follows:

Unit	Third Instar	Fourth Instar	Fifth Instar	Sixth Instar	Date Sprayed
Springfield	2.0%	4.9%	84.2%	8.9%	May 21
Pierce Creek	0.0	7.8	65.7	26.5	22
Cottage Grove	2.6	9.1	62.3	26.0	22
Brownsville	1.1	18.5	71.1	9.3	24
Oakridge	0.0	12.2	73.5	14.3	June 1

It should be stated that earlier application of spray by about four days would have undoubtedly been equally effective in killing the larvae. However, the insect development had been so unusually rapid and the resulting spray application date set so much earlier than anticipated that it was regarded as most fortunate that equipment and insecticide were made ready by May 21. Favored by good weather conditions all areas were sprayed before pupation occurred.

The Lowell and Oakridge units, respectively, some 20 and 40 miles distant from the large infestation near Springfield, presented difficult spray-scheduling problems. The Lowell area represented differences in elevation from about 600 to 3,000 feet and the Oakridge area from 1,400 to more than 5,000 feet. When new growth up to two inches long and sixth instar larvae could be found at the lowest levels the last week of May, buds were tight and second instar larvae were just emerging at the highest points. Snow was still found at the 5,000-foot level on June 2 at Oakridge. It was therefore necessary to extend spray operations over a longer period of time on these units. It was not until June 19 that larvae and foliage developed sufficiently to allow completion of the project at Oakridge.

Evaluation of Control

The problem of sampling the insect population before and after spraying, which provides an evaluation of control, proved to be somewhat difficult. The large size of most of the trees, and the absence of foliage near ground level required devising a sampling procedure different from that used on the Heppner project in 1948. There, relatively small trees with low-hanging foliage were readily sampled. In addition to the tree-size problem, the comparative inaccessibility of most western Oregon areas, due mainly to lack of passable roads and steep topography, presented the problem of adequately sampling the spray results on the extensive spray area--once a satisfactory technique was worked out.

Pre-Spray Sampling - The method of sampling finally employed was as follows:

1. Eleven plot lines of ten trees each were established in eleven more or less naturally defined spray areas that were regarded as being homogeneous with the stands being treated.

2. The plot lines were arranged so as to extend at right angles to the logical flight lines of the spray planes, rather than parallel.

3. The ten sample trees were spaced at intervals of approximately five chains along the extended lines. The spacing interval usually depended on the frequency of suitable sample trees, it being necessary to find trees having their lower branches extending to within a maximum of 18 feet of the ground.

4. By the use of a long-handled pole pruner with a muslin net attached beneath the cutting blade, 15-inch sample sprays were removed from the crown of the trees. These were carefully deposited on a white sheet for larval counting. Three sprays, each from a different side of the tree and located at different crown levels, constituted the sample. The total number of budworm larvae counted on the three sample sprays was then tabulated as representing the sample tree.

5. The sampled trees were tagged with numbered 3 x 5-inch white shipping tags. Tags were suspended loosely from branches so that a slight breeze would cause discernible movement, thus assisting in relocating the trees after spraying. Additional guide tags were hung between sample trees.

It was recognized that a somewhat biased sample was obtained in that: (A) the upper crown levels of the larger trees remained unsampled; and (B) it was necessary to restrict sampling to more or less open-grown limby trees in order that foliage could be reached from the ground. Examination of some climbed and felled trees, however, indicated no great concentration of larvae at any particular crown level. Furthermore, it was regarded that a somewhat conservative estimate of insect mortality due to the spraying would be obtained; mainly because there would likely be less spray deposited on the lower branches of heavy-foliaged trees in dense stands than on the tops. In any event, the method used seemed the only feasible approach when considering the large area to be sampled and the scarcity of time and personnel available to do the job.

Post-Spray Checking - Following spraying, the tagged trees were re-examined, repeating the same sampling procedure as used prior to spraying. All living larvae and pupae were tallied and tabulated against the count made prior to spraying. From these figures the percentage of kill on the spray units was computed. These results are summarized in Table III; a more detailed record is included in the Appendix of the report.

Subsequent larval counts on the sample trees were made at Coburg Hill seven days after the DDT application. Although heavy larval mortality was immediately obvious, a few could still be found on the trees. These, however, showed definite symptoms of DDT poisoning, and of 45 larvae taken into the laboratory, only 5 went on through to pupation. It was thus evident that seven days was not a sufficiently long period to permit all the afflicted larvae to die. This was substantiated, on plots

sprayed later, by the placing of cloth trays under trees to record the daily number and duration of dropping larvae. The heaviest drop was found to occur during the first 24 hours following spraying, with a gradual decline in number until figuratively no larvae were dropping 12 days after spray application. As the result of these findings, subsequent mortality checking was conducted on each plot about 13 days after spraying. Complete mortality records are given in Table III and Appendix V.

Natural Control

With time and facilities limited, no extensive parasite rearings or other natural control studies were accomplished. Many field observations were made, however, and small-scale parasite rearings conducted where feasible.

Parasite rearings of fourth, fifth and sixth instar larvae from Sodaville and Coburg showed less than ten percent parasitism. Collections of sixth instar larvae from Cottage Grove showed a parasitism percentage of 11.1 percent. Pupal collections from the Oakridge area yielded practically no parasites. Results of the rearings and general field observations gave no indication of an early end of the budworm epidemic through natural control.

RECOMMENDATIONS

In addition to the previously-mentioned safety precautions, the following are recommendations and suggestions concerning the shortcomings of the western Oregon spruce budworm control project. These are presented with the objective of further increasing the efficiency of subsequent projects. It is recommended that:

1. Single engine planes be powered with at least 450 h.p. engines.

2. Each airfield have an airplane mechanic.

3. Better spray tanks be used in planes. These should be made of non-metallic materials resistant to deterioration by spray materials thus minimizing leakage.

4. Spray tanks in planes be equipped with larger loading openings and air vents to permit faster loading.

5. Adequate gasoline gauges be equipped and periodically checked on all aircraft.

6. Planes have dump valves with at least 6-inch openings.

7. Loading nozzles be equipped with fast-opening and closing valves.

8. More storage space for insecticide be made available at airfields--at least one third of the total amount of insecticide should be in storage before the initial spraying.

9. At least two men be stationed at each airfield to handle plane loading and keep spraying progress records up to date.

10. A schedule of each day's spray program be made available to spray-deposit checkers.

11. More complete daily flight records be kept.

12. Checking of completeness of coverage and uniformity of spray patterns by aerial observation be used more extensively.

13. Photographs in color be taken of infested areas from the air, before and after spraying. These along with black and white photographs of the ground operations are of considerable value for report purposes.

14. Complete first aid equipment be available on all operations.

15. Proper fire protection equipment be available at airfields.

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APPENDIX I

Project Equipment, Services and Personnel

1. Aircraft

13 Stearman airplanes with spray equipment
3 helicopters with spray equipment

2. Storage

9,000 gallons storage space (in the form of portable tank trailers) at each airfield
Two 30,000 gallon stationary tanks
10,000 gallon railway tank cars at sidings

3. Plane Loading Equipment

Portable pumps
Metering equipment
Adequate pipe, hose and nozzles

4. Communication

Stationary radios
FX and Peanut portable radio sets

5. Weather Equipment

Wind gauges
Thermometers

6. Biological Equipment

Equipment for one biology laboratory

7. Insecticide Transportation

Truck tankers and trailers
Railway tank cars

8. Air Strip Building Equipment

Motor patrol grader
Water truck

9. Aircraft Maintenance and Service

Portable shop
Gasoline tank with motor pump
Oil and grease

10. Miscellaneous Field Equipment

Glass slides
Xylene cleaner
Carrying case
Collecting bags
Long-handled tree pruners
Hand pruning snips

Project Personnel

Project Director	John B. Woods, Jr.
Project Supervisor, South Half	Dick Berry
Project Supervisor, North Half	Alvin Lindsten
Technical Advisor (Bur. Ent. & Pl. Quar.)	R. L. Furniss
Chief Biologist (Bur. Ent. & Pl. Quar.)	Kenneth H. Wright
Assistant Biologist	Ed Hooven
Assistant Biologist	Wilbur Engstrom
Assistant Biologist	Al Fisher
Aircraft Company Representative	Herman Poulin
Chief Pilot	Al Ausve
Central Aircraft Field Representative	J. L. Mulcahy
Airplane Mechanic	Don Farnsworth
Airplane Mechanic	Sam Gregory
Helicopter Mechanic	Stan
Fischer Lumber Company Representative	Bill Wilt
District Ranger, Oakridge	Bill Cummings

District Warden, Eastern Lane Fire Patrol	Jacob Smith
Dispatcher, Eastern Lane Fire Patrol	John Hutchinson

Unit Personnel

Brownsville:

Airfield Supervisor	Frank Sargent
Checker	Gene Hanneman
Checker	Milton Easton
Weather Observer	Harold Dixon
Weather Observer	John Davidson

Springfield:

Airfield Supervisor	Dale Bever
Weather Observer	George Hoffman
Checker	Milton Easton

Marcola:

Airfield Supervisor	Dale Bever
Assistant Airfield Supervisor	Harold Dixon
Checker	Milton Easton
Weather Observer	Jack Gartz
Weather Observer	George Hoffman

Cottage Grove:

Airfield Supervisor	James Brigham
Weather Observer and Checker	Richard Quintus

Lowell:

Airfield Supervisor	Eugene Manock
Weather Observer	Buford Hayes
Checker	Harold Sasser

Oakridge:

Airfield Supervisor	James Brigham
Assistant Supervisor	Dale Bever
Weather Observer	Jack Gartz
Checker	Harold Plank

Pierce Creek:

Airfield Supervisor	Lee Harter
Checker	Harold Dixon
Weather Observer	Buford Hayes

Airplane Pilots

Sawyer	Snider	Anderson
Richardson	Richardson	Powell
Zaha	Bancroft	Munger
Murray	Sellers	Fugate
Griffin	Moore	

Helicopter Pilots

Ziffenblatt	Arni
Mead	Leopold

APPENDIX II-a

STATE-LANDOWNER AGREEMENT FORM

C-O-P-Y

STATE OF OREGON BOARD OF FORESTRY

SPRUCE BUDWORM CONTROL

Name of Owner_____

Address_____

Legal Description.

County_____

Estimated timbered acres_____

Date Contacted_____, 1949 By_____

_____

Landowner's Signature

I,_____, AGREE THAT_____acres is the correct area in timber on the above described lands.

_____

REMARKS

_____

APPENDIX II-b

FIRST LETTER TO OWNERS FROM OREGON STATE FORESTER

C-O-P-Y

Through a recent survey conducted by the State Board of Forestry and the Federal Bureau of Entomology, a serious infestation of spruce budworm has been detected in forests of Linn and Lane counties.

While this infestation is still in its early stages and serious killing of timber has not as yet occurred, past experience with the same insect in eastern forests has shown that if control measures are not undertaken a disastrous loss of timber resources can be expected.

Under the Insect Pest Control Act (section 107-261 to 107-270b, O.C.L.A.) the State Forester is directed to take immediate measures to control insect pest infestations as soon as they are detected. With the approval of the State Board of Forestry, he is directed to establish a zone of infestation and to notify all landowners within that zone as to the nature of the infestation and the control measures necessary. Upon the failure or inability of the landowners to take the necessary control measures, the State Forester is then directed to undertake a control program. Through cooperative agreements with the landowners the State Board of Forestry can participate in the costs of the project to the extent that available funds permit.

A control program will be conducted this coming summer on approximately 130,000 acres of infested forest areas in Linn and Lane counties. In view of the threat to the entire forest resource of western Oregon which this infestation represents, federal and state agencies have agreed to bear three-fourths of the costs of this project through state and federal appropriations. Since all the materials and services to be used on this project will be obtained through competitive bidding, it is impossible at this time to estimate accurately the total cost of the project. However, if the federal funds which have been requested are made available the costs to the private landowners should not exceed forty cents per acre.

According to the rolls of the County Assessor the following lands included within the area to be treated are under your ownership:

Within the near future a representative of this office will contact you personally to verify the ownership listing given above and to discuss with you a cooperative agreement relating to your participation in the project.

Very truly yours,

State Forester

APPENDIX II-c

SECOND LETTER TO OWNERS FROM OREGON STATE FORESTER

C-O-P-Y

Some time during the last month you received a letter notifying you of a serious infestation of the spruce budworm in the forests of Linn and Lane Counties. This letter stated that under the Insect Pest Control Act a zone of infestation had been declared and that control measures would be undertaken by the state forester during the month of June 1949.

The letter included a notice of the infested timber lands in your ownership. Acreages were taken from the County Assessor's records and were subject to some changes.

Subsequent to the receipt of the above-mentioned letter you were personally contacted by a member of the State Forestry Department whose purpose was to determine the correct acreage for which you are to be responsible and to ask for your cooperation in the project.

You will find enclosed two copies of an agreement covering the responsibilities of the landowner and the State Forester for this cooperative project. Please sign and return one copy. In regard to payment you may, (1) mail your portion of the estimated project cost (the amount indicated in ARTICLE II section 1 of the enclosed agreement) with the agreement, and we will return any overage when the final costs are determined, or (2) return the signed agreement and await receipt of our statement after completion of the project.

Very truly yours,

State Forester

DB/jk

Enclosure - 2

APPENDIX II-d

THIRD LETTER TO OWNERS FROM OREGON STATE FORESTER

C-O-P-Y

Earlier this year you were notified that a serious infestation of spruce budworm existed in the timber in your ownership or under your control and that a zone of infestation had been declared in accordance with the requirements of the Insect Pest Control Act, Section 107-261 to 107-270B, O.C.L.A. This letter also notified you that control measures would be undertaken and that private owners would be expected to bear one-fourth the cost of the project on their lands. Later you were contacted by a representative of the State Board of Forestry whose purpose was to determine the exact number of acres of forest land in your ownership.

Subsequent to the field examination you were mailed a cooperative agreement setting forth your responsibilities in the proposed project. This was not returned. Because of early advancement of the insects, it was necessary to divert all our personnel to the actual control program and consequently we were unable to contact you further regarding your contribution.

The project is now successfully completed. Fortunately, we are able to announce, the cost has been considerably reduced and the landowners' portion will be considerably less than the estimated forty cents per acre. Please find enclosed a statement of your portion of the project cost. Make checks payable to N. S. Rogers, State Forester, Salem, Oregon.

Very truly yours,

N. S. ROGERS
State Forester

By
Acting State Forester

DB/jk

Enclosure

APPENDIX II-e

C-O-P-Y

INSECT CONTROL COOPERATIVE AGREEMENT

This Agreement, made and entered into on this _____ day of _____, 1949 by and between _____, hereinafter referred to as the owner, and the State of Oregon, acting by and through its Board of Forestry, hereinafter referred to as the Board, witnesseth:

WHEREAS, a serious infestation of insects, commonly known as the spruce budworm, exists over an area of approximately 125,000 acres of timberland located in Linn and Lane Counties, Oregon; and

WHEREAS, the infestation has reached such proportions as to be harmful, detrimental and injurious to timber and forest growth, thereby constituting a public nuisance; and

WHEREAS, the Board has declared a zone of infestation and fixed the boundaries thereof as shown by a map on file in the State Forester's office at Salem, Oregon;

NOW THEREFORE, it is hereby mutually agreed as follows:

ARTICLE I. The Board shall:

1. Supervise and administer the work of controlling this infestation as provided herein.

2. Pay all costs connected with the work authorized herein.

3. Furnish the owner, upon completion of the work performed, an itemized statement of expenditures incurred by the Board in carrying out this agreement.

ARTICLE II. In consideration of the above, the owner shall:

1. Pay to the Board 25 percent of the total approved costs incurred in the control measures applied upon the following described lands, provided that the owner's share for such approved costs shall not exceed $_____.

Subdivision	Section	Township	Range	Acreage

ARTICLE III.

This agreement shall continue in effect to and including August 31, 1949, unless extended by written mutual consent of the parties hereto and subject to resolution of the Board.

IN WITNESS WHEREOF, the parties hereto have executed this agreement on the day and year above written.

OREGON STATE BOARD OF FORESTRY

_____
Witness

By_____
State Forester

_____
Witness

By_____
Owner

APPENDIX II-f

C-O-P-Y

COOPERATIVE AGREEMENT BETWEEN THE STATE OF OREGON AND THE UNITED STATES OF AMERICA FOR THE CONTROL OF THE SPRUCE BUDWORM IN LANE AND LINN COUNTIES, OREGON

THIS AGREEMENT, made this _____ day of _____, 1949, by and between the Oregon State Board of Forestry, by and through the State Forester, hereinafter referred to as the State, and the Forest Service and the Bureau of Entomology and Plant Quarantine, Department of Agriculture of the United States, by and through the Regional Forester, Forest Service, Region 6, hereinafter called the Government, WITNESSETH:

WHEREAS, the Douglas-fir and true fir timber on federal, state, county, and municipal lands, and privately owned lands, in the zone of infestation in Lane and Linn Counties, Oregon, as shown on the attached map, which is hereby made a part of this agreement, is now being attacked and destroyed by the spruce budworm, and the control of this insect is essential to protect the timber stands and to aid in preventing further spread of the infestation to adjoining federal lands and the forest lands of other owners, and

WHEREAS, the said lands are of intermingled ownership; are of such character, and so situated with respect to one another that it is to the mutual advantage of the parties hereto to cooperate in the suppression of the spruce budworm infestation in one unified operation; and

WHEREAS, the State under the provisions of the Insect Pest Act, Sections 107-261 to 107-270b, Oregon Coded Laws Annotated, is authorized to take measures to eradicate and destroy all destructive insects on forest lands within the State of Oregon; and

WHEREAS, the Regional Forester, as the delegated agent of the U. S. Department of Agriculture, may, under the authority of, and in accordance with the Act of Congress of June 25, 1947 (Pub. Law 110-80th Congress) enter into cooperative agreements with the State for the control of the said spruce budworm infestation; and

WHEREAS, the U. S. Bureau of Entomology and Plant Quarantine through its Forest Insect Laboratory at Portland, Oregon, is cooperating with the U. S. Forest Service and the Oregon State Board of Forestry, in forest insect control activities in Oregon, by providing technical advice, supervision, and guidance; and

WHEREAS, approximately three-fourths of the infested acreage is in state, county, municipal and private ownership and only one-fourth in federal ownership; and

WHEREAS, in consideration of the mutual benefits which will be derived under this agreement,

NOW, THEREFORE, it is mutually agreed by and between the parties hereto as follows:

Section 1. This operation shall be financed on the following basis: The cost of control on all federal lands shall be paid entirely by the United States. For state, county and municipal lands, the cost of control will be paid entirely by the State. On land in private ownership, the cost of control will be paid as follows: The Government, 25%; the State 50%; and private owners, 25%. It is understood that all monies to be provided by private owners shall be collected by the State. No payments shall be made or obligations incurred in excess of amounts appropriated by Congress of the United States and the Legislature of the State for this insect control project and funds contributed by private owners contributing to this control project.

Section 2. For the period covered by this agreement the State shall administer and supervise the control and eradication operations on the federal, state, county, municipal and private lands, and will carry out the treating schedules set up by the U. S. Bureau of Entomology and Plant Quarantine. These schedules provide for the application of spray from airplanes for the control of the spruce budworm within the zone of infestation shown on the attached map. A spray of not more than one pound of technical DDT in solvent and fuel oil to make one gallon of spray, will be applied at the rate of one gallon per acre.

Section 3. In carrying out its responsibilities as outlined in Section 2 the State shall issue competitive bids to secure materials and services at the lowest possible costs; the bid specifications for such materials and services shall meet the requirements of the Bureau of Entomology and Plant Quarantine for this project. The Government reserves the right to inspect the insecticide and the spraying as the project progresses.

Section 4. All costs of the control work will be paid from State funds with the understanding that the Government will reimburse the State for the Government's share as herein provided. Upon the completion of the control project, the State shall determine the average cost per acre for the total area sprayed and furnish the Government with an itemized, certified invoice showing (1) total direct costs, (2) the total acreage sprayed by ownerships. The Government will then reimburse the State at the full per-acre cost rate for the federal lands sprayed and at 25 per cent of the per-acre cost rate for private lands sprayed.

In computing the actual cost per acre only the direct charges for the insecticide and its application shall be included.

Section 5. This agreement shall be in force from the date hereof to_____, both dates inclusive, or until the cooperative work on said lands is completed, unless sooner terminated in the manner provided, or by agreement of the parties hereto.

It is contemplated that this agreement may be terminated by mutual consent thereto if entomological observations by the Bureau of Entomology and Plant Quarantine shall establish beyond question that the infestation has been suppressed by climatic or other natural factors.

Section 6. In accordance with the provisions of the above cited Acts, the United States shall not be liable for the costs or value of any property injured or destroyed, nor shall the United States be liable for any damages incident to cooperation hereunder.

Section 7. The State Forester of Oregon is hereby designated as the agent of the United States for the purpose of carrying out the control measures under this agreement.

Section 8. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this agreement or to any benefit to arise therefrom. Nothing, however, herein contained shall be construed to extend to any incorporated company, if this agreement be for the general benefit of such corporation or company.

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed as of the date hereinabove written.

Oregon State Board of Forestry

by_____
State Forester

_____
Regional Forester, Region 6
U. S. Forest Service

APPENDIX II-g

C-O-P-Y

SUPPLEMENTAL COOPERATIVE AGREEMENT BETWEEN THE STATE OF OREGON BY AND THROUGH THE OREGON STATE BOARD OF FORESTRY AND THE UNITED STATES OF AMERICA BY AND THROUGH THE REGIONAL FORESTER, FOREST SERVICE, REGION 6 FOR THE CONTROL OF THE SPRUCE BUDWORM IN LANE AND LINN COUNTIES, OREGON

THIS AGREEMENT, made this 27th day of May, 1949, by and between the State of Oregon by and through the Oregon State Board of Forestry, hereinafter referred to as the State, and the Forest Service and the Bureau of Entomology and Plant Quarantine, Department of Agriculture of the United States, by and through the Regional Forester, Forest Service, Region 6, hereinafter called the Government, WITNESSETH:

WHEREAS, it now appears that the area shown as infested by the spruce budworm on the zone of infestation map which accompanied the cooperative agreement of May 18, 1949, as executed by the State Forester for the Oregon State Board of Forestry and by the Regional Forester, Region 6, for the U. S. Forest Service is incomplete, and

WHEREAS, it is deemed necessary by the two said agencies and the U. S. Bureau of Entomology and Plant Quarantine to spray adjoining forested acreages in private, state and federal ownership,

NOW THEREFORE, it is mutually agreed by and between the parties hereto that the spraying of such additional area as shown on the attached map shall be immediately undertaken. It is further agreed that all of the provisions of the agreement of May 18, 1949, entitled "Cooperative Agreement Between the State of Oregon by and through the Oregon State Board of Forestry and the United States of America by and through the Regional Forester, Forest Service, Region 6 for the Control of the Spruce Budworm in Lane and Linn Counties, Oregon" shall apply with equal effect to the treatment of the additional infestation shown on the attached map which is hereby made a part of this supplemental cooperative agreement.

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed as of the date hereinabove written.

OREGON STATE BOARD OF FORESTRY

by_____
State Forester

_____
Regional Forester, Region 6
U. S. Forest Service

APPENDIX III-a

SPRAYING BID

C-O-P-Y

INVITATION TO BID

To furnish equipment for aerial spraying of forest areas infested with spruce budworm in Linn and Lane Counties, Oregon.

1. Bid to Cover

a. Aircraft as specified below to be used in the application of spray insecticide.

b. Equipment as specified below to be used in the transportation of insecticide from railhead to airstrips; for the storage and agitation of insecticide at airstrips; for the loading of aircraft with insecticide and for the maintenance of aircraft.

c. Personnel as specified below, including a project supervisor and adequate qualified personnel for the operation and maintenance of aircraft and facilitating equipment.

2. Aircraft Specifications

a. At least ten (10) airplanes of the Stearman - Travelair - Waco - N3N class equipped with single engines of at least 300 H. P. Each airplane must be equipped with spraying apparatus capable of distributing spray of a regulated particle size at a uniform measured rate. Spraying apparatus must include the following specific parts and features:

(1) An insecticide tank with a capacity of at least 80 gallons. This tank must be fitted with an adequate emergency dump valve.

(2) A pumping system including a suitable pump and an adjustable pressure relief valve, together capable of maintaining a constant set pressure of at least 25 pounds per square inch at varying flying speeds.

(3) A pressure gauge mounted in the cockpit.

(4) A quick-acting shut-off valve.

(5) Booms constructed of one-inch or larger pipe or tubing and fitted with a sufficient number of suitable nozzles to provide the desired rate of application and the desired particle size.

All planes specified above must be assembled on the project area prior to the commencement of spraying operations at a time and place to be specified by the Oregon State Board of Forestry.

b. At least five (5) stand-by airplanes to be available upon 24 hours' notice when and if, as a result of weather conditions, insect developments, equipment failures or other circumstances, the State Board of Forestry finds that the ten airplanes specified above will be unable to complete the project within the time available. Stand-by airplanes must be equipped with spraying apparatus meeting the specifications listed above and must have single engines of at least 300 H. P. Any type of airplane will be acceptable if it has been tested and successfully employed on extensive commercial spraying operations over mountain terrain.

c. At least two (2) helicopters equipped with boom-type pressure spraying apparatus capable of applying spray of a regulated particle size at a uniform measured rate. Any type of helicopter will be acceptable if it has been tested and successfully employed on extensive spraying operations.

These helicopters must be assembled on the project area prior to the commencement of spraying operations at a time and place to be specified by the State Board of Forestry. They will be employed to spray Block VII (see attached map) which is a mountainous area of between 10,000 and 15,000 acres isolated from the balance of the project and outside practical range of developed airstrips.

d. At least one (1) stand-by helicopter to be available upon 24 hours' notice when and if the State Board of Forestry finds that the two helicopters specified above will be unable to complete the spraying of Block VII within the available time. This helicopter, likewise, must be of a tested type and must be equipped with adequate spraying apparatus.

3. Facilitating Equipment Specifications

a. For each of the two or more airstrips to be simultaneously employed at least one tank truck for transportation of insecticide from railhead to airstrip.

b. Storage facilities at each of the two or more airstrips to be simultaneously employed. The combined capacity of storage facilities and tank truck at each airstrip must be sufficient for at least one day's operation of at least five airplanes.

c. Adequate equipment at each of the two or more airstrips to be simultaneously employed for the agitation of insecticide in storage tanks and for the rapid and efficient loading of aircraft. Airplane loading system must be equipped with meters for the accurate measurement of loads.

d. At each airstrip all additional equipment necessary for the continuous operation and maintenance of aircraft.

e. Adequate transportation, storage, loading and maintenance equipment for the continuous and efficient operation of the helicopters specified above.

4. Personnel Requirements

The successful bidder must provide:

a. An operation supervisor to be stationed on the project for its duration. He will, under the direction of the Oregon State Board of Forestry, plan, organize, direct and inspect all operational phases of the project. To qualify he must previously have actively directed the simultaneous operation of five or more aircraft on a dusting or spraying operation. In order that he can properly orient pilots and check their work, he must have an observation airplane at his disposal at all times.

b. Adequate qualified personnel for the operation and maintenance of all aircraft. Each pilot must have flown at least 250 hours on commercial spraying or dusting operations.

c. Adequate qualified personnel for the operation and maintenance of facilitating equipment.

5. Area to Be Treated

The area to be treated will consist of seven blocks of forest area as shown on the attached map. It may be found necessary to treat additional acreages adjacent to or in the vicinity of Block VII, but in no event will the total acreage to be sprayed be less than 120,000 acres or more than 130,000 acres.

The State Board of Forestry will provide the successful bidder with aerial photographs and maps of the areas to be treated. In addition, the Board will provide men familiar with the territory who will fly with the operations supervisor and pilots to acquaint them with specific areas to be sprayed.

6. Time of Application

Due to the habits of the insect to be treated, the period during which effective control can be achieved will not exceed 10 to 14 days. The

exact time for the commencement of spraying operations and the sequence of treatment of individual blocks will be determined by insect development. Continuous entomological observations will be made prior to and during the spraying operations and all decisions relative to times and sequence of applications will be made by the State Board of Forestry and will be transmitted to the operations supervisor.

In no event will spraying operations begin earlier than June 1, 1949 or later than July 1, 1949.

7. Rate and Method of Application

Insecticide shall be applied at a uniform rate of one (1) gallon per acre over the entire project area. Checking stations will be maintained by the State Board of Forestry in all areas as the spray is applied, and any inadequacies in spray distribution shall be corrected by the successful bidder without additional expense to the State Board of Forestry.

The insecticide shall be applied as a mist with an average spray particle size of 150 to 300 microns. Checks of particle size will be made by the State Board of Forestry and variations from the standard must be corrected without delay by the operational supervisor.

Spray application shall be made within 100 feet of tree-top level. The State Board of Forestry will maintain weather stations on the project area while applications are being made. Whenever the wind velocity exceeds six (6) miles per hour, whenever air turbulence is excessive and whenever rain or other atmospheric conditions will diminish the effectiveness of the spray, spraying operations shall be discontinued.

8. Spray Material

The spray material to be used on this project will consist of DDT dissolved in a solvent and diluted in fuel oil with one (1) pound of DDT in each gallon of solution. This material will be delivered without cost to the successful bidder to railheads convenient to the project area.

9. Airstrips

As indicated on the attached map, there are several developed airstrips in the vicinity of the project area. The efficient operation of the number of aircraft to be employed will require simultaneous operation from at least two airstrips in addition to the helicopter base. All arrangements for the use of airstrips and any preparatory development work necessary will be the responsibility of the successful bidder.

10. Performance Bonds and Guarantee

Before the contract shall be awarded, the successful bidder shall be required to post cash or surety bond in the amount of twenty-five

thousand and no/100 ($25,000.00) dollars to guarantee his faithful performance of the terms of the contract. Forfeiture shall not be demanded if the contractor's failure to complete the spraying operation is the result of weather conditions, insect developments or other unusual and unforeseeable circumstances beyond his control.

The State Board of Forestry shall not be under obligation to pay for any aircraft except those requested by the Board and made available at airstrips properly equipped for spraying insecticides. In the operation of such aircraft either for a full day or for a fractional part thereof, the successful bidder shall be paid the contract rate for such operation. When one or more aircraft are requested by the Board and such aircraft are on the airstrips and ready for immediate operation, and such operation is prohibited by weather conditions, status of insect development, or other extraordinary and unforeseeable conditions, the successful bidder shall be entitled to and shall receive as rent for the use of each aircraft, meeting the requirements set out in this instrument, fifty and no/100 ($50.00) dollars per day for each airplane and one hundred and no/100 ($100.00) dollars per day for each helicopter.

The maximum rental to be paid by the Board for all types of aircraft made available and not used shall not exceed the sum of fourteen thousand seven hundred and no/100 ($14,700.00) dollars, providing the above mentioned conditions are found existing, but if the successful bidder operates any aircraft in compliance with the terms of the contract entered into, then such rental shall be reduced by the amount due and payable under the contract, and when the amount to be paid under the terms of the contract shall equal or exceed the above stated maximum rental, then the rental provision hereof shall not be applicable and the Board shall not be obligated to pay rent for said aircraft under any circumstances.

11. Liability

The successful bidder shall be solely responsible for any injury arising from the operation of any and all aircraft and other equipment in the carrying out of the above operation. This provision shall not apply to any injury from or as a result of the insecticide.

12. Certified Statement

To receive consideration each bid must be accompanied by a certified statement giving:

a. Descriptions, license numbers and evidence of availability of all airplanes and helicopters specified above.

b. Descriptions and evidence of availability of all facilitating equipment specified above.

c. The names of all airplane and helicopter pilots to be employed with the number of flying hours each has completed on spraying or dusting operations.

d. The name of the proposed operations supervisor with a record of his experience in directing extensive spraying or dusting operations.

e. Evidence of the availability of facilitating personnel specified above.

f. Evidence of the ability of the bidder to provide performance surety specified above.

The State Board of Forestry reserves the right to inspect the bidder's aircraft and facilitating equipment before the contract is awarded.

13. Composite Bid Asked

Bidder is requested to submit a rate per acre bid, said rate to include all equipment and services specified heretofore.

$\$$_____

APPENDIX III-b

INSECTICIDE BID

C-O-P-Y

INVITATION TO BID

126,000 gallons DDT spray insecticide to meet the following specifications:

Formulation

The insecticide shall be formulated in the following proportions:

1 pound of DDT to 1.25 quarts of auxiliary solvent, and sufficient fuel oil to bring the mixture to 1 gallon at 60 to 70 degrees F.

The finished product shall be free of lint, silt and foreign matter of all kinds. Provisions shall be made for the State Board of Forestry to make such tests as may be necessary to insure conformity of the product or any of its components with the specifications. The minimum flash point shall not be less than 175 degrees F.

DDT Specifications

The DDT used in the formulation of the insecticide shall be technical grade DDT (Dichlo-Diphenyl-Trichloroethane) having the following physical characteristics:

	Minimum	Maximum
1. Setting point, degrees C.	89	
2. Organic chlorine, % by wt.	48	51
3. Ash content, % by wt.		0.5
4. Chloral hydrate, % by wt.		0.025
5. pH by extraction	5.0	8.0
6. Water soluble material, % by wt.		0.25

Auxiliary Solvent Specifications:

The auxiliary solvent used in the preparation of the insecticide shall consist principally of hydrocarbons and shall have the following physical characteristics:

1. Flash point, degrees F.	175 minimum
2. Distillation range degrees F.	
Initial boiling point not less than	360
Final boiling point not greater than	750
3. Viscosity, SU at 100 degrees F.	30 to 55 seconds
4. DDT solubility at 30 degrees C.	30% by st. minimum

Fuel Oil Specifications

The fuel oil used in the preparation of the insecticide shall be No. 2 fuel oil, Federal specifications VV-o-326.

Points of Delivery

The prepared insecticide shall be delivered in bulk shipments to John B. Woods, Jr., Assistant State Forester, in the quantities and at the points of delivery listed below:

Oakridge, Oregon	16,000	gallons
Cottage Grove, Oregon	10,000	"
Brownsville, Oregon	48,000	"
Eugene or Springfield, Oregon	52,000	"
	126,000	"

Dates of Delivery

At least one third of the quantity of insecticide listed for each point of delivery shall be delivered on or before June 1, 1949. Two thirds of the quantity listed for each point of delivery shall be delivered on or before June 10, 1949; and the final delivery of all quantities listed shall be completed on or before June 15, 1949.

Storage and Demurrage

The successful bidder shall pay all tank car demurrage charges or other storage costs incurred during a period not to exceed 30 days after the date specified for final delivery.

Successful bidder will be required to furnish a Performance Bond in the amount of $10,000.00.

APPENDIX IV

LARVAL DEVELOPMENT BY UNITS - SPRUCE BUDWORM SPRAY PROJECT 1949

BROWNSVILLE UNIT:

Date	Larval Stage: Second Instar(%)	Third Instar(%)	Fourth Instar(%)	Fifth Instar(%)	Sixth Instar(%)	Total (%)
4-27-49 (Broke winter hibernation - approx.)						
5-12	2.0	5.0	79.0	14.0		100
5-13	3.0	14.0	76.0	7.0		100
5-14	3.9	7.8	83.5	4.8		100
5-18		4.8	75.0	20.2		100
5-19		5.2	27.8	64.9	2.1	100
5-20		4.0	21.0	62.0	13.0	100
5-21		3.2	17.9	78.9		100
5-22			20.4	71.8	7.8	100
5-23		1.1	18.5	71.1	9.3	100
5-24 (Sprayed)						

SPRINGFIELD UNIT:

4-25-49 (Broke winter hibernation - approx.)						
4-29	36.0	60.0	4.0			100
5-3	25.0	40.5	34.5			100
5-11		12.0	60.3	27.7		100
5-12		5.0	66.0	29.0		100
5-13		1.9	20.9	77.2		100
5-14	1.1	4.4	5.5	86.8	2.2	100
5-17		2.0	12.9	84.1	1.0	100
5-18			13.7	83.4	2.9	100
5-19			7.7	83.6	8.7	100
5-20		2.0	4.9	84.2	8.9	100
5-21 (Sprayed)						

PIERCE CREEK UNIT:

4-27-49 (Broke hibernation)						
5-11		7.4	59.3	33.3		100
5-13	0.9	17.7	71.7	9.7		100
5-18		4.9	19.4	74.7	1.0	100
5-19 (Low Elev.)			12.9	48.5	38.6	100
(Mod. High Elev.)		8.1	38.7	53.2		100
5-20		4.0	10.9	81.1	4.0	100
5-21			15.3	60.2	24.5	100
5-22 (Sprayed)			7.8	65.7	26.5	100

LARVAL DEVELOPMENT BY UNITS - SPRUCE BUDWORM SPRAY PROJECT 1949 (Cont.)

COTTAGE GROVE UNIT:

Date	Larval Stage: Second Instar(%)	Third Instar(%)	Fourth Instar(%)	Fifth Instar(%)	Sixth Instar(%)	Total (%)
4-27-49 (Broke hibernation)						
5-17		9.1	20.0	65.4	5.5	100
5-19		3.6	16.1	73.2	7.1	100
5-20		9.0	10.0	70.0	11.0	100
5-22 (Sprayed)		2.6	9.1	62.3	26.0	100

OAKRIDGE UNIT (Low Elevation)

(Exact time of emergence from hibernation not known)						
5-17-49	2.9	61.8	26.5	8.8		100
5-20	16.5	11.3	68.7	3.5		100
5-24	2.2	6.7	54.4	36.7		100
5-26		2.1	66.7	31.2		100
5-28			12.2	73.5	14.3	100
6-1 (Sprayed)						

Note: The daily collections at each unit consisted of approximately 100 larvae.

APPENDIX V

MORTALITY COMPUTATIONS BY AREAS
WESTERN OREGON SPRUCE BUDWORM SPRAY PROJECT - 1949

KAMPFER RANCH (PIERCE CREEK UNIT)

Tree Number	Species	Number Larvae Prior To Spraying (3-15" Sprays)	Population After Spraying (3-15" Sprays) Larvae	Pupae
1	D. Fir	19		
2	" "	37		
3	" "	38		
4	" "	36	1	
5	" "	42	5	
6	" "	48	6	
7	" "	35		
8	" "	56	1	
9	" "	21	3	
10	" "	21	2	
	Totals	353	18	0

Kill = 94.9%

PIERCE CREEK (PIERCE CREEK UNIT)

1	D. Fir	54	1	
2	" "	74		
3	" "	82		
4	" "	16	1	
5	" "	79		
6	" "	76	2	
7	" "	55		
8	" "	100		
9	" "	12		
10	W. Fir	61		
	Totals	609	4	0

Kill = 99.3%

COTTAGE GROVE (COTTAGE GROVE UNIT)

1	D. Fir	6		
2	" "	9		1
3	W. Fir	3		
4	D. "	19	5	
5	" "	22		
6	" "	14		
7	W. "	25		
8	D. "	20		
9	" "	5		
10	" "	19		
	Totals	142	5	1

Kill = 95.8%

MORTALITY COMPUTATIONS BY AREAS
WESTERN OREGON SPRUCE BUDWORM SPRAY PROJECT - 1949
(Continued)

COUGAR MOUNTAIN (COTTAGE GROVE UNIT)

Tree Number	Species	Number Larvae Prior To Spraying (3-15" Sprays)	Population After Spraying (3-15" Sprays) Larvae	Pupae
1	D. Fir	39		
2	" "	65		
3	" "	47		
4	" "	39		
5	" "	30		
6	" "	52		
7	" "	76		
8	" "	85		
9	" "	32		
10	" "	96		
	Totals	561	0	0

Kill = 100.0%

SEAVIES RANCH (SPRINGFIELD UNIT)

1	D. Fir	73		
2	" "	41		
3	" "	30	3	
4	" "	84	2	1
5	" "	83	1	
6	" "	108	6	1
7	" "	72	1	
8	" "	14		
9	" "	60		
10	" "	81	3	
	Totals	646	16	2

Kill = 97.2%

SODAVILLE (BROWNSVILLE UNIT)

1	D. Fir	67		
2	" "	32		
3	" "	27	1	
4	" "	43		
5	" "	32	1	
6	" "	61		
7	" "	40	1	
8	" "	14	1	
9	" "	15		
10	" "	31		
	Totals	362	4	0

Kill = 98.9%

MORTALITY COMPUTATIONS BY AREAS
WESTERN OREGON SPRUCE BUDWORM SPRAY PROJECT - 1949
(Continued)

MT. SCOTT (BROWNSVILLE UNIT)

Tree Number	Species	Number Larvae Prior To Spraying (3-15" Sprays)	Population After Spraying (3-15" Sprays) Larvae	Pupae
1	D. Fir	13		
2	" "	15		
3	" "	42		
4	" "	32		
5	" "	14		
6	" "	10		
7	" "	18		
8	" "	23		
9	" "	33		
10	" "	10		
	Totals	210	0	0

Kill = 100.0%

LOWELL (LOWELL UNIT)

1	D. Fir	3	1	
2	" "	7		
3	" "	2	1	
4	" "	3	2	
5	" "	5		
6	" "	1		
7	" "	3	3	
8	" "	14	4	
9	" "	38		
10	" "	15		
	Totals	91	11	0

Kill = 87.9%

GOBEL CREEK (OAKRIDGE UNIT)

1	D. Fir	11		
2	" "	9		
3	" "	8		
4	W. Fir	6		
5	D. "	18		
6	" "	11		
7	" "	5		
8	" "	10		
9	W. Fir	6		
10	D. "	10		
	Totals	94	0	0

Kill = 100.0%

MORTALITY COMPUTATIONS BY AREAS
WESTERN OREGON SPRUCE BUDWORM SPRAY PROJECT - 1949
(Continued)

AUBREY MOUNTAIN (OAKRIDGE UNIT)

Tree Number	Species	Number Larvae Prior To Spraying (3-15" Sprays)	Population After Spraying (3-15" Sprays)	
			Larvae	: Pupae
1	D. Fir	52		
2	" "	64		
3	" "	122		
4	" "	76	7	13
5	" "	37	1	1
6	" "	13		
7	" "	105		1
8	" "	54		1
9	" "	29		
10	" "	7	1	
	Totals	559	9	16

Kill = 95.5%

McCREDIE SPRINGS (OAKRIDGE UNIT)

1	D. Fir	14		
2	" "	5		
3	" "	6		
4	" "	6		
5	" "	5		
6	" "	10		
7	" "	13		
8	" "	17		
9	" "	16		
10	" "	5		
		97	0	0

Kill = 100.0%

APPENDIX VI

PLANE PERFORMANCE RECORD - SPRUCE BUDWORM CONTROL PROJECT 1949

Block	Total Gals.	Total Trips	Avg. Gals. Per Trip	Total Time (Hr.)	(Min.)	Avg. Time Per Trip (Min.)	Field	Avg. Flight Distance (Mile)
Plane License N5155N - Type Stearman - 300 H.P. - Pilot Sawyer								
2	1,645	17	96.6	6	21	22.4	Brownsville	6.0
3	1,320	14	94.4	5	23	23.1	Brownsville	4.8
4	1,658	19	87.3	6	24	20.2	Brownsville	4.2
7	1,980	22	90.0	7	20	20.0	Brownsville & Pierce Creek	4.4
20	1,120	12	93.4	4	49	24.1	Brownsville	5.0
39	1,248	16	78.0	7	04	26.5	Springfield	7.5
51	3,520	41	85.9	14	40	21.5	Marcola	4.3
	12,491	141	88.6	52	01	22.1		5.0
Plane License 1145N - Type Stearman - 450 H.P. - Pilot Richardson (West Air)								
8, 10	2,119	16	132.3	5	19	19.9	Brownsville	1.9
23	1,681	13	129.3	4	59	23.9	Pierce Creek	3.7
26	2,349	17	138.2	6	56	24.5	Brownsville	6.0
38	1,737	13	133.5	6	05	28.1	Springfield	7.4
50	3,565	26	137.2	9	22	21.6	Marcola	4.5
58*	1,831	13	141.0	4	34	21.1	Marcola	8.5
	13,282	98	135.5	37	15	22.8		5.1
Plane License 75590 - Type Stearman - 450 H.P. - Pilot Zaha								
24	1,536	13	118.1	5	25	25.0	Pierce Creek	5.8
28	1,325	11	120.5	4	12	22.9	Pierce Creek	5.5
29, 33	2,421	19	127.4	7	34	23.9	Pierce Creek	4.7
52	4,170	34	122.6	13	18	23.5	Marcola	2.1
6 Oakridge	2,301	17	135.2	6	46	23.9	High Prarie	11.3
7 Oakridge*	1,056	8	132.0	3	46	28.3	High Prarie	8.0
10 Oakridge*	557	4	139.3	1	32	23.0	High Prarie	8.4
12 Oakridge	2,655	19	139.7	7	51	24.8	High Prarie	11.5
13 Oakridge	2,390	17	140.5	6	03	21.4	High Prarie	8.3
59	2,950	23	128.3	8	26	22.0	Marcola	9.4
	21,361	165	129.6	64	53	23.6		7.1

* Block completed by another pilot.

PLANE PERFORMANCE RECORD - SPRUCE BUDWORM CONTROL PROJECT 1949 (Cont.)

Block	Total Gals.	Total Trips	Avg. Gals. Per Trip	Total Time (Hr.)	(Min.)	Avg. Time Per Trip (Min.)	Field	Avg. Flight Distance (Mile)
Plane License N5158N - Type Stearman - 300 H.P. - Pilot Murray and Griffin (Medford Air)								
12	1,349	14	96.4	4	07	17.7	Pierce Creek	4.3
32	1,967	20	99.4	5	11	15.5	Pierce Creek	2.8
35	4,059	42	96.6	15	06	21.6	Pierce Creek	5.2
48*	1,006	12	83.8	4	19	21.6	Marcola	9.3
49	2,255	24	94.0	8	05	20.2	Marcola	5.8
	10,656	112	95.1	36	48	19.7		5.2
Plane License 1054N - Type Stearman - 300 H.P. - Pilot Snider (Medford Air)								
21	1,380	21	65.7	7	19	20.9	Pierce Creek	4.6
22	1,680	26	64.6	7	22	17.0	Pierce Creek	3.7
30	3,088	47	65.7	24	17	31.0	Pierce Creek	2.8
31	2,484	36	69.0	11	38	19.4	Pierce Creek	2.5
48*	348	5	69.6	1	44	20.8	Marcola	9.3
56	3,155	45	70.1	14	24	19.2	Marcola	7.0
58*	485	7	69.3	2	10	18.6	Marcola	8.0
	12,620	187	67.5	68	54	22.1		4.4
Plane License 44940 - Type Stearman - 300 H.P. - Pilot Richardson (Yakima Air)								
54	1,980	25	79.2	7	10	17.2	Marcola	2.7
57	1,142	15	76.1	4	35	18.3	Marcola	7.2
	3,122	40	78.1	11	45	17.6		4.4
Plane License 49293 - Type Stearman - 450 H.P. - Pilot Bancroft								
16	2,452	15	163.5	4	54	18.4	Brownsville	1.6
17	870	6	145.0	2	28	24.7	Brownsville	2.7
18, 19	3,696	22	168.0	7	50	21.4	Brownsville	4.3
58*	1,640	10	164.0	3	57	23.7	Marcola	8.0
	8,658	53	163.4	19	09	21.7		4.1

* Block completed by another pilot.

PLANE PERFORMANCE RECORD - SPRUCE BUDWORM CONTROL PROJECT 1949 (Cont.)

Block	Total Gals.	Total Trips	Avg. Gals. Per Trip	Total Time (Hr.)	(Min.)	Avg. Time Per Trip (Min.)	Field	Avg. Flight Distance (Mile)
Plane License 57173 - Type Stearman - 450 H.P. - Pilot Sellers								
1 Cottage Grove	1,090	11	99.1	4	17	23.4	Cottage Grove	4.1
2 Cottage Grove*	1,072	11	97.5	6	28	35.3	Cottage Grove	5.2
3 Cottage Grove*	342	3	114.0	1	55	38.3	Cottage Grove	6.7
5 Cottage Grove*	1,360	14	97.1	6	41	28.6	Cottage Grove	2.6
6 Cottage Grove*	776	7	110.9	3	06	26.6	Cottage Grove	3.0
7 Cottage Grove	1,996	16	124.8	8	34	32.1	Cottage Grove	4.8
	6,636	62	107.0	31	01	30.0		4.1
Plane License M57049 - Type Stearman - 450 H.P. - Pilot Moore								
41	2,704	23	108.2	9	22	22.5	Springfield	6.0
44	2,620	25	104.8	8	44	21.0	Springfield	6.8
2 Cottage Grove*	233	2	116.5	0	52	26.0	Cottage Grove	5.2
3 Cottage Grove*	344	3	114.8	1	22	27.3	Cottage Grove	6.7
4 Cottage Grove	472	4	118.0	1	58	29.5	Cottage Grove	6.2
5 Cottage Grove*	916	8	114.5	3	44	28.0	Cottage Grove	2.6
6 Cottage Grove*	346	3	115.3	1	26	28.7	Cottage Grove	3.0
7 Cottage Grove*	2,436	22	110.7	10	45	29.6	Cottage Grove	4.8
	10,071	92	109.5	38	13	24.9		5.6
Plane License 45142 - Type Stearman - 300 H.P. - Pilot Anderson								
55	3,041	38	80.0	12	21	19.5	Marcola	4.0
Plane License 63070 - Type Stearman - 450 H.P. - Pilot Powell								
1	2,571	21	122.4	9	19	26.6	Pierce Creek & Brownsville	7.8
5	4,640	38	122.1	11	56	18.8	Brownsville	3.8
15	2,032	17	119.5	6	09	21.7	Brownsville	3.4
40	2,191	17	128.9	7	10	25.3	Springfield	5.8
45, 46, 47	5,150	42	122.6	16	01	23.0	Brownsville & Marcola	7.8
	16,584	135	122.8	50	35	22.5		5.9

* Block completed by another pilot.

PLANE PERFORMANCE RECORD - SPRUCE BUDWORM CONTROL PROJECT 1949 (Cont.)

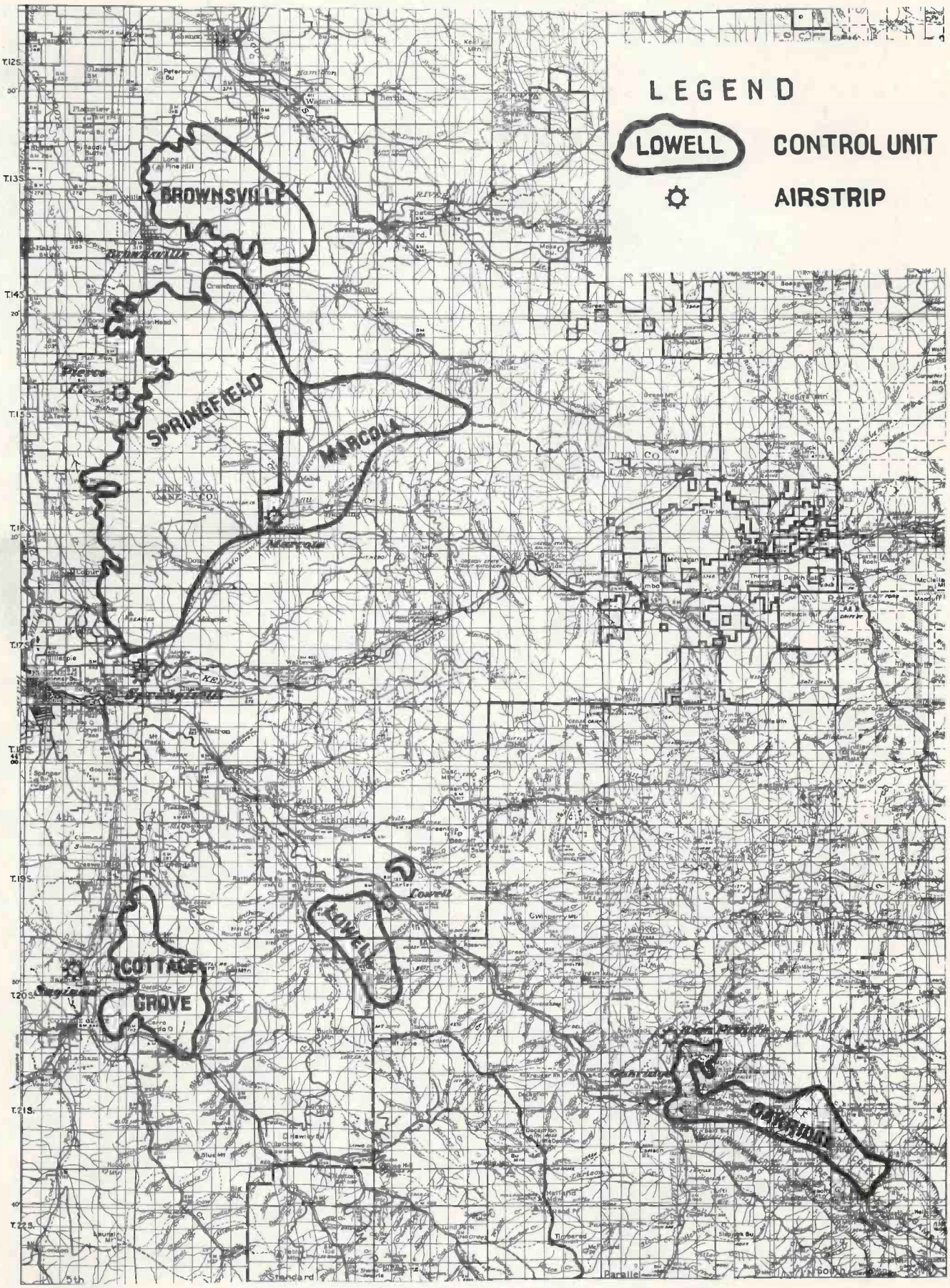
Block	Total Gals.	Total Trips	Avg. Gals. Per Trip	Total Time (Hr.)	(Min.)	Avg. Time Per Trip (Min.)	Field	Avg. Flight Distance (Mile)
Plane License N49285 - Type Stearman - 450 H.P. - Pilot Munger								
34	2,624	21	125.0	8	07	23.2	Pierce Creek	4.8
36	1,120	9	124.4	4	26	29.6	Springfield	8.7
37	2,504	22	113.8	9	47	26.7	Springfield	7.4
42	1,424	13	109.5	5	12	24.0	Springfield	4.2
43	2,720	25	108.8	10	23	24.9	Springfield	3.6
53*	1,119	8	139.9	2	40	20.0	Marcola	2.8
	11,511	98	117.5	40	35	24.8		5.2
Plane License 57440 - Type Stearman - 450 H.P. - Pilot Fugate								
6	980	8	122.5	2	49	21.1	Brownsville	4.4
9	3,255	26	125.2	9	16	21.4	Brownsville	4.0
11	2,330	21	111.0	6	39	19.0	Brownsville	2.9
13	2,030	17	119.4	7	27	26.3	Pierce Creek	5.0
14	1,924	16	120.3	6	00	22.5	Pierce Creek & Brownsville	4.4
25	1,024	8	128.0	2	54	21.8	Brownsville	5.8
27	1,712	13	131.7	4	46	22.0	Marcola	6.4
53*	3,163	24	131.8	6	38	16.6	Marcola	2.8
	16,418	133	123.4	46	29	21.0		4.2
Helicopter License N101B - Type H - 178 H.P. - Pilot Ziffenblatt								
1 Lowell	1,202	24	50.1	8	03	20.1	Lowell	2.5
3 Lowell*	255	5	51.0	1	08	13.6	Lowell	2.5
7 Lowell	1,426	28	50.9	8	34	18.4	Lowell	2.5
8 Lowell*	506	10	50.6	3	26	20.6	Lowell	2.5
7 Oakridge*	150	3	50.0	0	59	19.7	Aubrey Mountain	6.5
9 Oakridge	1,100	22	50.0	8	37	23.5	Aubrey Mountain	5.5
11 Oakridge*	101	2	50.5	0	30	15.0	Aubrey Mountain	2.9
14 Oakridge	320	8	40.0	2	03	15.4	Aubrey Mountain	3.0
15-16 Oakridge*	790	17	46.5	5	04	17.9	Aubrey Mountain	3.2
	5,850	119	49.2	38	24	19.4		3.3

* Block completed by another pilot.

PLANE PERFORMANCE RECORD - SPRUCE BUDWORM CONTROL PROJECT 1949 (Cont.)

Block	Total Gals.	Total Trips	Avg. Gals. Per Trip	Total Time (Hr.)	(Min.)	Avg. Time Per Trip (Min.)	Field	Avg. Flight Distance (Mile)
Plane License N21H - Type H - 178 H.P. - Pilot Mead and Arni								
3 Lowell*	651	15	43.4	4	57	19.8	Lowell	2.5
5 Lowell	805	16	50.3	5	54	22.1	Lowell	2.5
6 Lowell	730	16	45.6	5	31	20.7	Lowell	2.5
8 Lowell*	951	18	52.8	5	10	17.2	Lowell	2.5
9 Lowell	559	13	43.0	3	14	14.9	Lowell	2.5
	3,696	78	47.5	24	46	19.1		2.5
Plane License 1458 - Type H - 178 H.P. - Pilot Leopold								
2 Lowell	1,692	34	49.8	7	11	12.7	Lowell	2.5
3 Lowell*	720	15	48.0	5	15	21.0	Lowell	2.5
4 Lowell	254	5	50.8	1	03	12.6	Lowell	2.5
1 Oakridge	352	8	44.0	1	47	13.4	Aubrey Mountain	2.1
2 Oakridge	450	9	50.0	2	24	16.0	Aubrey Mountain	1.5
3 Oakridge	425	9	47.2	2	51	19.0	Aubrey Mountain	0.6
4 Oakridge	398	10	39.8	2	01	12.1	Aubrey Mountain	0.8
5 Oakridge	580	12	48.3	3	27	17.3	Aubrey Mountain	3.0
8 Oakridge	750	15	50.0	3	31	14.1	Aubrey Mountain	1.2
10 Oakridge*	1,143	23	49.7	6	27	16.8	Aubrey Mountain	6.2
11 Oakridge*	1,550	31	50.0	7	45	15.0	Aubrey Mountain	2.9
15-16 Oakridge	250	5	50.0	1	56	23.2	Aubrey Mountain	3.2
17 Oakridge	1,001	20	50.1	7	03	21.2	Aubrey Mountain	2.8
18 Oakridge	498	10	49.8	3	11	19.1	Aubrey Mountain	3.0
	10,063	206	48.8	55	52	16.3		4.8
Total for Airplanes	146,451	1354	108.2	509	59	22.5		4.9
Total for Helicopters	19,609	403	48.6	119	02	18.3		3.5
TOTAL	166,060	1757						

* Block completed by another pilot.


LEGEND
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CONTROL UNIT
AIRSTRIP
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